POWER

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ELY C. HUTCHINSON, *Editor*

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The Cost of a Customer

"LOOK at that outfit. A few pounds of cast iron and of brass or bronze at so much a pound. So many days' work at so much a day. And look at what they charge for it."

When you buy an appliance or a piece of apparatus you buy a lot more than the material in it and the labor of its production.

You make your contribution to the compensation of the man who conceived the idea and worked out the invention of the device, of the designer and promoter who reduced it to a practical machine adapted to your purpose.

This may be a simple application of a fortuitous idea, but it is often the consummation of years of study and effort, of failure and grief and discouragement, of costly research and experiment.

You pay your part of the cost of the shop and machinery for its manufacture, of its taxes, insurance, heating, lighting, maintenance and administration.

And when the device has been perfected and is ready to serve your purpose it costs a lot to let you and others who can use it to advantage know that it is available.

You learn of it through a salesman or an advertisement. Both cost money, and you are the one who pays for them. You write for prices, and if it is an installation of sufficient importance a visit of a skilled representative or at least correspondence involving engineering computation and design, selection or adaptation is necessary.

If you invite bids from a number of builders you pay your part of the consequent expenses of all of them, for the dealer from whom you buy must charge you enough to cover your pro rata of the cost of his unsuccessful bids.

And when the apparatus is bought and installed the manufacturer is as anxious as you are exigent that it shall be satisfactory and effective. Which means that he must keep an eye upon it and upon you and be ready to straighten out any difficulty in its operation, usually at greater cost than compensation, if any is charged.

The mere price of material and labor may be a small proportion of the cost to the manufacturer of a satisfied customer.

EDITORIALS

Engineers' Commissions

A COPY of the recently adopted Code of Ethics of the American Refractories Institute has just been received. It represents an effort to eliminate unfair trade practices, unfair competition, and economic waste, and in many respects is similar to codes adopted by other trade associations. It contains one clause that warrants special emphasis. This has to do with "commissions," concerning which it states:

"No commission or discount, direct or indirect, should be paid to an engineer, contractor, boiler setter, furnace builder, or any one directly or indirectly connected with any buyer's organization."

A similar code has just been adopted by the Steel Heating Boiler Institute.

In some trades the practice has been so long in vogue as to become accepted. For instance, the paper hanger usually figures his commission on the paper as a part of his estimates, and, if the paper is purchased by the owner, the commission is added to the labor charge. Painters, as a rule, do likewise.

Among the professions, the case is somewhat different. To what extent the doctor and the druggist, the oculist and the optician, the general practitioner and the specialist are in cahoots, is a matter of conjecture. The practice is undoubtedly less prevalent than formerly, because of professional strictures, and in most cases may be more apparent than real.

Consulting engineers probably indulge in the practice to a lesser extent than men in some other lines; yet the fact that trade associations and professional engineering societies see fit to take cognizance of the point is an indication of the tendency. Moreover, now and then one hears of specific cases involving reputable manufacturers and well-known engineers.

It is said that some of these engineers pass along the commission to their clients. If power plant equipment were standardized to the extent that prices were uniform, any price concession that the engineer might obtain in the form of a commission, which he passed along to his client, might be justified from his viewpoint, although economically unsound in the broader sense. But such is seldom the case, and commissions are likely to be reflected in the price of the product or in the service rendered the purchaser. Where, then, is the advantage?

If the commission is not passed on to the client the practice cannot be defended from any angle. It is an injustice to the client, to the industry and to the reputation of the engineer himself.

Overworking a Research Problem

THE HASTE with which a research worker steals away to his laboratory when intent upon solving some problem is usually prompted by sound business judgment; for the experienced scientist or engineer knows that once his fellow-savants learn of his experiments they will begin to stir their own caldrons. This situation seems to have risen in connection with Diesel fuel oil.

For many years builders of Diesel engines have recommended to purchasers of their engines, fuel oil of a most varied character. Consequently, the oil refiner either had to make up special batches or keep a number of tanks to meet the often unreasonable variation in oil demanded by an engine user. This resulted in high oil prices, and both the refiner and the engine builder suffered by the limitations of their sales brought about by the high price.

In spite of obvious need for classification, the situation remained in the same muddled condition until the Oil and Gas Power Division of the American Society of Mechanical Engineers initiated a movement that led to the appointment of a research subcommittee on Diesel fuel standardized specifications. This committee, composed of engine builders, oil refiners and engine operators took hold of the problem in a practical way. Many samples of oils have been made up by the refiners and tested by the engine builders and operators. While the characteristics of a suitable fuel have not been defi-

nitely determined, undeniable progress has been made and an experimental specification has been drawn up.

With the subcommittee working assiduously, the American Society of Testing Materials, which had ignored the problem for years, took the position that it should be the sole authority in matters of oil specification, although conceding that the A.S.M.E. was the proper agency to engage in research pertaining to engine design. Apparently the A.S.T.M. has failed to grasp the fact, so obvious to engine builders and oil refiners, that oil characteristics and engine design are closely related.

The situation was met by the A.S.M.E. gracefully conceding to the A.S.T.M. the privilege of establishing oil specifications, although the A.S.M.E. subcommittee will continue its work.

Now a new voice is heard—the Society of Automotive Engineers has decided that the subject is so pertinent to the automotive industry that it must have its own committee of research and standardization. Influenced, no doubt, by the popular idea that soon automobiles will be driven by Diesels, the S.A.E. thinks it should set out on this mission of oil research.

With several engineering bodies planning to issue specifications, the future of Diesel fuel oil seems as gloomy and as hopeless as it has been in the past.

According to the Viewpoint

IT WILL BE RECALLED that a serious power shortage, from drought, was averted recently in Tacoma by the Navy Department's permitting the airplane carrier Lexington to augment the city supply for a period of thirty days.

As a sequel to this, the N.E.L.A. has just issued a news bulletin containing some formidable figures, calculated to show what it cost the country to render such assistance. The Navy Department received approximately $100,000 for this service, at .2⅓ cents per kilowatt-hour. Against this is figured the cost of fuel, upkeep, pay and subsistence of the ship's personnel, plus fixed charges on this 41-million-dollar ship, including depreciation and obsolescence, the sum total of which is placed at $600,000 per month. The difference, $500,000, the bulletin points out, "must be borne by the taxpayers of the whole country."

The fact remains, assuming these figures to be correct, that in the absence of this emergency tie-in the Lexington would have cost the taxpayers $600,000, instead of $500,000, during this period, besides which some of the industries of Tacoma would have suffered loss through curtailed production.

All things considered, it does not appear to have been such a bad bargain for the Navy nor for the city, even though the latter, to meet an emergency, had to resell this power at a lower figure to conform to the existing consumer rate.

A New "Racket" For Steam Fitters?

DISGUISED as a measure in the interest of public health and safety, a new, legalized "racket" threatens the owners and builders of power plants in the State of New York. A bill now before the legislature in Albany will, if carried, tie the hands of power men with impractical restrictions and encumber their plants with red tape and politicians.

Practically the same bill came up a year ago and was killed. Now, as then, it is proposed to amend the 1921 labor laws.

Briefly, the plan is this: A division of steam power and heating plants will be set up in the Department of Labor, with practical pipe fitters as inspectors. A code for the construction and alteration of steam power and heating plants is to be prepared. All plans for new plants and alterations must be submitted for approval (with $10). Existing plants are subject to review. All master steam fitters must register and get cards. Those found working on a plant without cards will be subject to heavy fines. Further details are given in the news section of this number of *Power*.

Complete enforcement of this bill would be impossible. A strictly law-abiding plant owner could not connect a one-inch outlet to an existing low-pressure steam main without first filing plans (with $10) and patiently waiting for official approval. Plants already built must conform to a future code. If the plants do not fit the code, they may have to be rebuilt.

As the bill reads, it applies to every phase of plant construction. Steam fitter inspectors may even pass on furnace-wall construction, turbine foundations, switchboards and stacks. Nothing, apparently, is exempt.

Granting an honest difference of opinion as to the desirability of supervision over the installation of power equipment, besides boilers, the problem should be approached through a collaboration of the best engineering thought and experience and not as prescribed by this bill.

At the best, this bill will create a nuisance, open new political jobs to waste tax money and new avenues for petty graft. The bill, if passed, is to go into effect July 1. A hard winter is ahead if the prospective victims do not act quickly and decisively.

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POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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Extensive Distribution of Natural Gas Makes GAS ENGINES

Outside of oil fields, the gas engine has trailed the other forms of prime movers. Now, however, with its vitality revived by the opening of new natural-gas fields, the gas engine is sprinting into a competitive position.

By L. H. MORRISON
Associate Editor POWER

THE gas engine has become economical again. This has been brought about not through any marked increase in thermal efficiency, but by the tapping of almost limitless natural gas fields, and the construction of a vast network of pipe lines.

In California the state now refuses to permit drilling of oil wells unless the gas content can be disposed of. This forces the oil producer to sell the gas cheap enough to justify pipe lines to San Francisco and other cities.

From the Amarillo, Texas, field, lines lead to Denver, Colo, and intermediate cities. Gas is made available at El Paso, Texas, from the west Texas field, while central Texas and Oklahoma are covered with a network of feeder lines, with main lines reaching downward to the Gulf Coast and northward to Kansas City, Mo., and to many Kansas towns, with a projected extension to Nebraska.

From the Monroe, La., field, the gas that for years was extravagantly wasted in making lamp black now flows to New Orleans, Memphis and St. Louis, and eastward to Atlanta, Ga. In Indiana, Ohio and Pennsylvania hundreds of feeder lines deliver gas to main lines leading to the principal cities. In Fig. 1 an attempt has been made to show the major gas lines now in existence, but the thousands of miles of feeders and secondary lines, especially in Oklahoma, Ohio, Indiana and Pennsylvania, are not included.

In spite of its limitations, the map will give the reader a general idea of the important gas sources and pipe lines. Primarily, these lines are intended to supply household fuel, but in order to write off the investment at the earliest possible date, the gas is being sold for industrial heating and for boiler use.

To make gas competitive with coal and oil for boiler use, the price must be low. Consequently, one encounters rates varying from 5 cents per 1,000 cu.ft., where the buyer is located close to the gas field and uses a large amount, up to $1 per 1,000 cu.ft. As gas has an average heating value of 1,000 B.t.u. per cubic foot, taking into consideration its somewhat better furnace efficiency, at $1 per 1,000 cu.ft. it is equal to coal at $14 per ton.

In the soft-coal sections of the country, coal is obtainable at from $1 to $2.50 per ton at the mines, which freight rates will raise to a delivered price of from $2 to $6. To compete with $2 coal, boiler gas must sell for about 9 cents per 1,000 cu.ft., and at 25 cents to compete with $6 coal.

Apparently gas cannot be carried any great distance and compete with coal, save for such purposes as domestic heating, industrial furnaces and steam boilers where advantages outweigh the price differential.

On the other hand, a user of power can afford to burn the gas in an engine for the reason that it employs the fuel more efficiently than does a steam plant, and can afford to burn a relatively expensive gas.

In Fig. 4 is a curve that gives approximate values for the heat units required by a gas engine at various loads, assuming a heat content of 1,000 B.t.u. per cubic foot.

For example, let us take an industrial plant that requires an average of 200 hp. for eight hours daily and

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operates 20 days a month. To care for the peak loads the motor or engine should have a capacity of 240 hp. To make the costs ascertainable, the plant will be placed on the line whose rates are given in Table I.

TABLE I—GAS RATES OF ONE PIPE LINE

Monthly consumption, Cu.Ft.	Cost per 100 Cu.Ft.
First 400	$0.225
Next 600	0.15
Next 1,000	0.12
Next 1,000	0.075
Next 7,000	0.06
Next 90,000	0.05
Next 400,000	0.025
Next 500,000	0.02
Next 1,000,000	0.018
Next 1,000,000	0.016
Excess	0.015

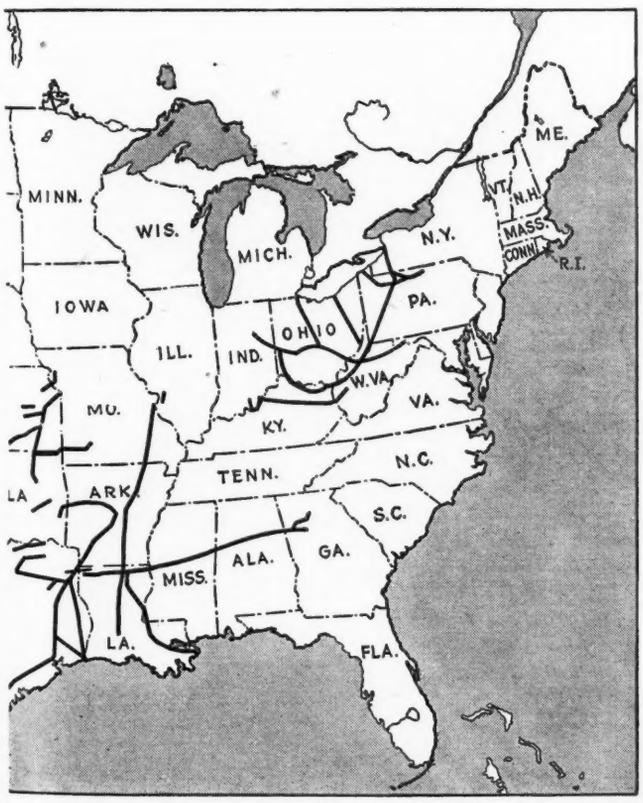


Fig. 1—Lines that make natural gas available to hundreds of towns

Fuel consumption will be 2,000 cu.ft. per hour, or 320,000 cu.ft. per month, with an output of 32,000 hp.-hr., or 28,800 kw.-hr. Using the values given in the tabulation the monthly fuel cost is obtained as follows:

Cu.Ft.	
400	$.90
600	.90
1,000	1.20
1,000	.75
7,000	4.20
90,000	45.00
220,000	55.00
320,000	$107.95

While it is usual for the engineer of such small plants to devote some of his time to other work, his entire time will be charged to the engine; and based on the scale of wage of engineers in plants of this capacity, the labor item should not exceed $160 a month.

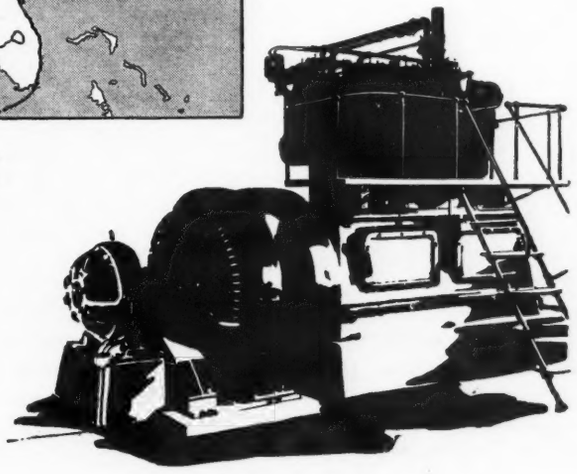
Lubricating oil will be at a rate of 1 gal. per day, or 20 gal. per month, which at $0.55 will bring this item to $11 a month.

Repairs, using the average for the engine's life, should not exceed $480 a year, or $40 a month. There should be a normal charge for water, say around $10 a month. Collecting the several items of: Fuel $105.95; labor $160; repairs $40; lubricating oil $11; and water $10—the monthly cost of power with a gas engine would be $326.95. To this must be added the overhead charges of, say, 15 per cent on $16,000, bringing the total monthly power cost to $526.95, or 1.8 cents per kilowatt-hour.

If the engineer's time is taken up in part with other work, as is usual in plants of this size, the power plant can be credited with the proper amount, correspondingly reducing the cost.

Inspection of the sliding scale of gas prices reveals that as the engine output increases the fuel cost per horsepower decreases. Consequently, with a plant of 500 hp. hourly output the cost of generation is still lower. Furthermore, as the overhead charges make up about half the total cost, a plant operating two shifts will reduce its unit power costs considerably below those calculated.

Undoubtedly, for factories requiring large amounts of power the gas engine is a sound investment where gas can be obtained at a low rate. Also, when the load is seasonal and comparatively small the advantages of the gas engine are equally obvious. An example of this is the cotton gin, which operates about 100 days a year, during which time the load is 100 per cent of the rating and the hours of operation from ten to twenty per day. This is a most unfavorable load for an electric company, for the yearly use factor is low. But if the ginner is to make a profit, the cost must be low, and gas power is economical in such situations. For example,



a five-stand 80-saw outfit will require 120 hp. Since the man who attends the engine busies himself with other work, the labor cost can be neglected, as, for instance, in the case of a motorized plant. This brings the generating cost for a 120-hp. unit down to 60 cents per hour, or the ginning power cost will be about 12 cents per bale, a figure considerably below that obtainable with most other forms of power.

Due to the employment of gas engines in the oil fields for gasoline recovery compression plants, as well as use for compressor drive in old gas line stations, there are many designs of gas engines to meet almost any industrial requirement. Present-day natural-gas engines range from 20 to 2,000 hp. in capacity, and the available designs include single-cylinder single-acting two-stroke-cycle units of low power, as well as twin engines having two double-acting four-stroke-cycle cylinders attached to each frame.

In the intermediate capacities present-day engines are

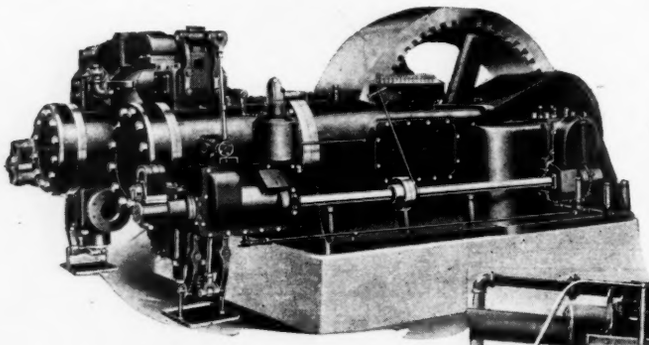


Fig. 2—A modern horizontal gas engine for belt drive

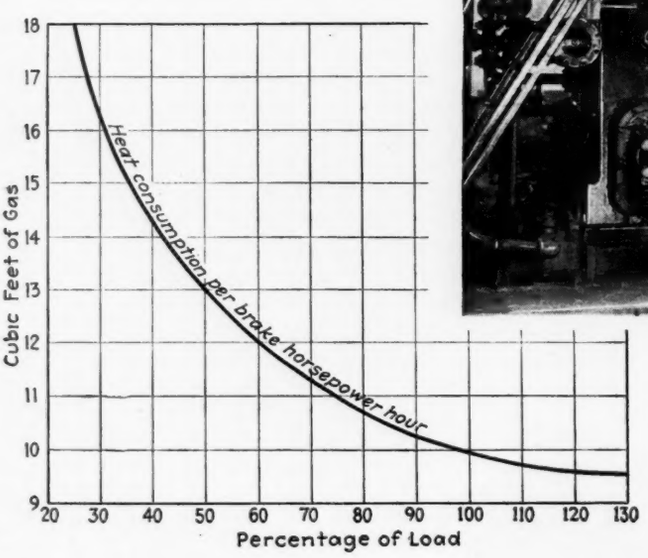


Fig. 3—Gas used by an engine to deliver a horsepower-hour

built in many varieties and shapes. Unlike its oil counterpart, the gas engine still employs the horizontal frame, with, of course, some exceptions. Apparently, the vertical engine finds its real market in the range from 165 to 375 horsepower.

When the power requirements exceed 2,000 hp. there are blast-furnace-gas engines available in capacities up to 10,000 hp. These can be arranged, without undue cost, to operate on natural gas.

The outstanding feature of many of the present-day designs is the marked improvement in fuel consumption. At one time an engine was expected to use at least 11,000 B.t.u. to develop a brake-horsepower-hour, frequently the smaller units actually used 12,000. This low thermal efficiency of 21 per cent was traceable to imperfect air-gas mixture in the cylinder at the time combustion began. To overcome this, designers have proceeded along two paths: One class has essayed, and quite successfully, too, to shape the cylinder combustion space to set up enough turbulence to insure a thorough mixing, and at the same time provide means to completely scavenge the cylinder of the gases after combustion.

Other designers have set about to improve mixing of the gas and the air before admission into the cylinder, regardless of governor action at load changes. One such improvement consists of a series of perforated tubes placed radially in the intake line so that the gas issues into the air in a series of minute streams. The resulting decrease in fuel consumption is remarkable; at present engines can be obtained that use about 8,500 to 9,000 B.t.u. per horsepower-hour.

Other improvemens include greater accessibility of engine parts. In former days the engineer was forced to remove all the valves and valve gearing to inspect or withdraw a piston. Now a piston can be removed

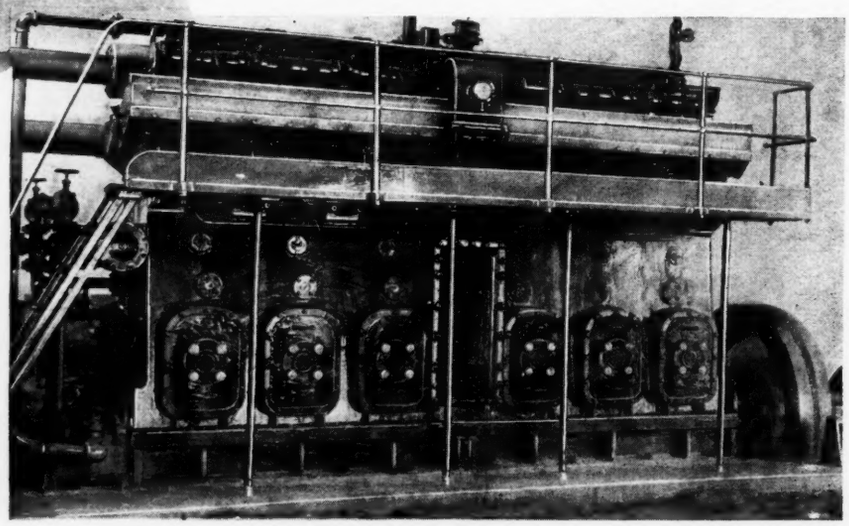


Fig. 4—A vertical engine that uses either gas or oil as fuel

through the cylinder head without disturbing the valves.

As has been mentioned, the gas engine suffered a lapse in popularity when the supply of natural gas and produce gas diminished. Engine builders are prepared to safeguard a gas-engine purchaser against any such contingency in the future. Most of them are able to supply an engine which can burn gas as long as it is available and then it can be adapted to fuel oil whenever this becomes economically advisable. This modification may be the replacement of the cylinder head to give a higher compression, and the addition of a fuel pump; or, as one builder is prepared to do, the engine may be a Diesel using natural gas instead of fuel oil while operating on the high-compression constant-pressure cycle.

There is every reason to justify the statement that the new gas fields are recreating a demand for gas engines.

Causes and Prevention of CORROSION On Hydro Machinery

By RAY S. QUICK
Executive Engineer
The Pelton Water Wheel Company

Corrosion and erosion of water-power machinery occurs under many conditions. The causes of these actions and the preventives that may be applied by designers and operating engineers are outlined. Consideration is also given to the economics of applying these correctives.

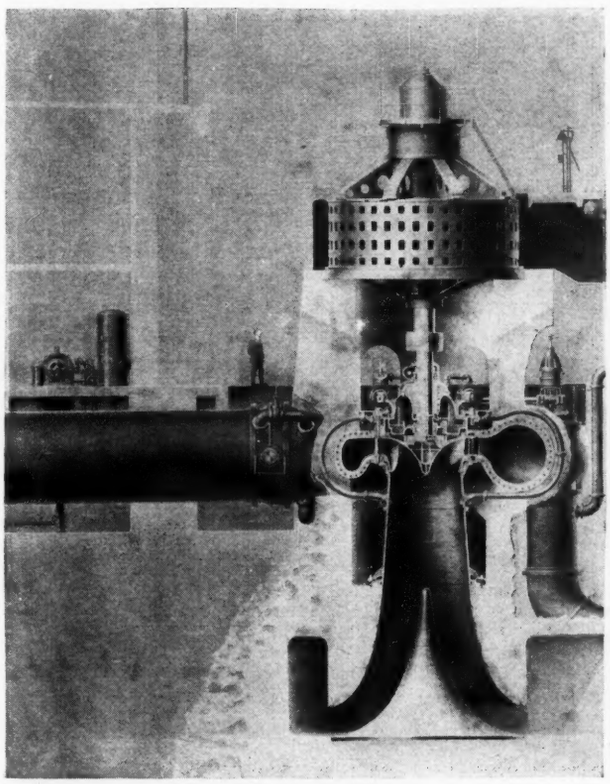


Fig. 1—Cross-section of a 33,000-hp. hydro-electric unit operating under 280-ft. head

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HYDRAULIC POWER machinery is subject to both corrosion and wear resulting from the action of the power water and the foreign materials which it often carries. Distinction should be made between corrosion and erosion. The former is deterioration due to chemical action, familiar forms being rusting of iron and steel and tarnishing of rustless materials, such as aluminum, copper, brass and nickel. The latter, in contrast, is wear or scouring action resulting from abrasion, appearing to some extent even with pure water, but accelerated by the presence of silt or sand at high velocities. Examples of these effects are shown in the photographs.

Normal useful life, neglecting the influence of improvements in the art of design and manufacture, is determined by the length of time the working parts maintain satisfactory strength, reliability and efficiency. Under favorable conditions water-power equipment has operated for 30 yr. practically continuously, though requiring certain essential maintenance and replacement of parts where wear was concentrated, but on the whole with very little trouble and expense. Under unfavorable conditions, the useful life of major working parts exposed to the action of the power water has been destroyed in a few months' time. It is therefore necessary, in selecting equipment for a given installation, to consider the characteristics of the power water and setting of the equipment to secure maximum wearing life and economy. This involves not only a thorough knowledge of design to select working parts of adequate strength and efficiency, but of material to resist corrosion and wear.

The products of corrosion usually are removed from the parent material by water at a moderate velocity, ex-

posing new metal for further attack. As a result, in regions of high relative velocities, serious scouring may develop which appears to be erosion, whereas the deterioration has been due largely to corrosion. This condition has developed in a few cases where the power water has carried traces of active corrosive reagents, in the wear of high-head waterwheel nozzles where tough alloy steel parts have been worn out in a few months' time. In one case stainless steels of special composition were substituted and showed practically no evidence of wear under the same conditions of service.

Reaction turbines with high draft settings are often subject to rapid pitting of the runner on local areas of high vacuum. This corrosion appears to be due to the action of free oygen liberated from the water, and it attacks practically all generally used materials with great rapidity. The obvious correction of this condition is to remove the local areas of partial vacuum by lowering the draft head or by improving the runner-vane form.

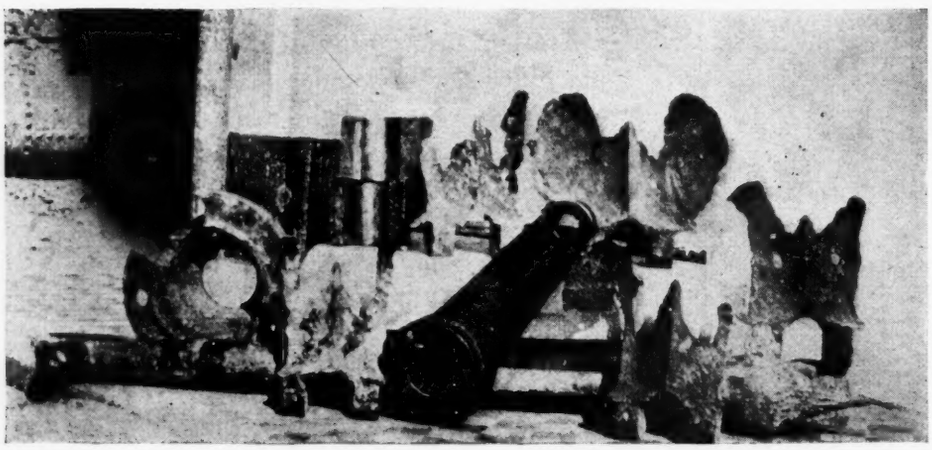


Fig. 2—Action of acid on waterwheel parts that were in service a short time

Iron and steel, being the strongest and most economical materials, are used widely in fabricating structures handling power water, from the headgate to the tailrace. Both designer and operator of this equipment must have a general knowledge of the characteristics of corrosion and erosion in order that suitable materials and protection be provided when built and that a normal useful life be assured. The action of rust alone on iron and steel may destroy the usefulness of an installation in a short time if neglected. Experience, of course, is the best guide for improvements, as the action of the sun, wind, rain and other elements in a given locality may produce results appreciably different from those at some other. Extensive research is now being undertaken by several national engineering organizations to reduce the vast economic loss resulting from corrosion.

There are several well-known methods for protecting materials from corrosion due to moisture in the air and submergence in water. Probably the most economical and widely used is paint. It gives a pleasing appearance, but protection against corrosion and decay is the primary purpose. Paints, enamels, lacquers, and special preparations with a metallic base, such as aluminum paint, are now widely used for the protection of the exterior of metal surfaces. Interiors of hydraulic pipe lines and submerged waterpower machinery are usually covered with paint to protect the metal surface as long as possible. Inspections made at definite intervals will indicate the protection afforded and help to determine the advisability of further applications. Preparation of the surface is an important factor in assuring adherence of a coating.

Considerable attention has been given in recent years to rendering iron and steel rustless by the addition of such elements as copper, nickel, chromium, etc., but with the exception of high chromium alloys, which produce the so-called stainless steels, rusting does not appear to be permanently arrested by them. The additional cost of such alloy steels may lead the designer to select ordinary iron and steel products and rely upon protective coatings to delay rust. There is little doubt, however, that the additional cost of rustless materials for certain wearing parts is more than justified by economic considerations. This is particularly true where paints or other protective coatings are made ineffective by the scouring action of water passing over the surfaces at a high relative velocity, by the small clearances available, or by the sliding contact of two metallic surfaces.

Plating working surfaces of hydraulic power machinery with such rustless materials as nickel has not been widely practiced. This is due not only to first cost, but to the pores that exist in practically all such applications. The latter allow corrosion of the underlying iron and

Fig. 3—Effects of erosion on waterwheel parts that were in operation several years

Fig. 4 — Corrosion of turbine due to partial vacuum at local areas created by abnormal operation

Fig. 5—Runner Fig. 4 restored to practically new condition by electric welding

steel to begin and soon remove the coating. Metal sprays have not been employed to any great extent, for the same reason. Where the protection of metal surfaces in sliding contact is necessary, surfaces of brass, monel, and other such tough rustless materials are customarily employed.

Stationary equipment such as trash racks is sometimes galvanized, as this appears to satisfactorily protect the submerged parts and to resist the abrasion of floating débris. Lubrication of submerged working parts is difficult, and special under-water lubricants which maintain their qualities should be used. Development of high-pressure industrial-type lubricating systems has done much to improve this situation.

Special corrosion problems arise when the power water carries chemicals such as acids, alkalies and salts. Some of these chemicals are corrosive in themselves. A case in point is the action of sulphuric acid, originating from volcanic formations, that caused rapid destruction of iron and steel parts inadequately protected. Fig. 2 shows the results of this acid reaction on the iron and steel working parts of a waterwheel unit installed in Bolivia. The buckets have almost disappeared, in some cases in a short time. This condition may virtually be prevented by constructing the wetted parts of brass or bronze. In a similar case in Japan, the problem was solved by protecting all wetted working parts of the waterwheel units with bronze and lining the penstock with sheet lead.

When the water is an electrolite, galvanic action may be set up between two submerged dissimilar materials in contact. This situation is encountered in the construction of ocean-going vessels, but is seldom met with in waterwheel work, as practically all such installations use fresh water. It will, however, be experienced when installations are made where the head is created by the rise and fall of the ocean tide.

A typical case of erosion is shown in Fig. 3, the equipment having been in service several years with a satisfactory working life. The small bucket in the background is made of bronze, and after nearly twenty years of steady use still shows the normal form, though worn practically as thin as paper. The small needle point shows clearly the scouring action of gravel and sand.

A cross-section of a modern large capacity vertical-shaft reaction turbine is shown in Fig. 1. This is one of three units installed at the Pit River No. 3 plant of the Pacific Gas & Electric Company, and is rated 33,000 hp. at 225 r.p.m. under 280-ft. net head. Plate-steel pipeline and discharge liners are used,

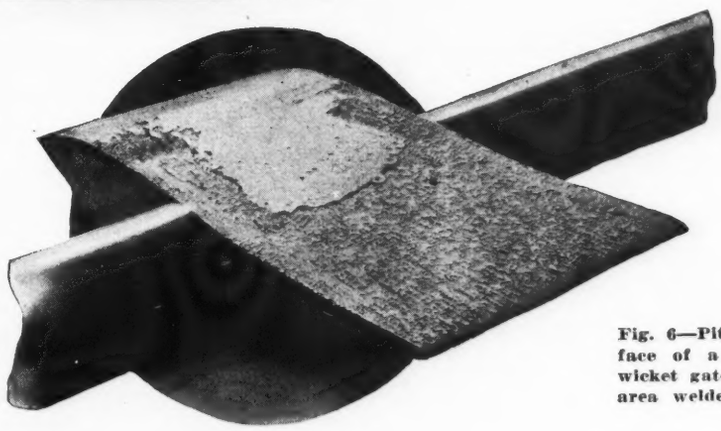


Fig. 6—Pitted surface of a turbine wicket gate; white area welded metal

while the butterfly shut-off valve, turbine scroll case and runner are of cast steel. The spindles of the steel wicket gates are supported in bronze bushings, grease-lubricated by high-pressure equipment. On the main shaft the guide bearing is of the oil-lubricated babbitted type. Protection against corrosion of the interior wetted surfaces is secured by paints. The exterior of the equipment open to view is likewise painted to resist rust and improve the appearance.

An example of corrosion of a turbine runner, due to partial vacuum at local areas created by abnormal operating conditions, is indicated in Fig. 4. Being of cast bronze, it was possible to renew the damaged parts by electric welding and to make the runner almost new, as

shown in Fig. 5. Electric arc welding of a pitted wicket gate brought the surface back to approximately new condition. Subsequent use indicated the welded surface to be tougher than the parent metal, as indicated by Fig. 6. The bright central patch is that built up by welding.

A large-capacity impulse turbine of the horizontal type appears in Fig. 7. The exterior is painted and all polished surfaces oiled to prevent rust and to improve the appearance. All wetted surfaces are painted where possible and where surfaces are in sliding contact they are faced with rustless materials of substantial thickness. This unit is one of two installed in the Big Creek 2A plant of the Southern California Edison Company, and develops a maximum output of about 70,000 hp. at 250 r.p.m. under a 2,230-ft. net operating head. The power water is taken from Shaver Lake, where all silt and other solid particles which would produce rapid erosion are settled out. The importance of having clear power water is further appreciated when it is realized that the sprouting

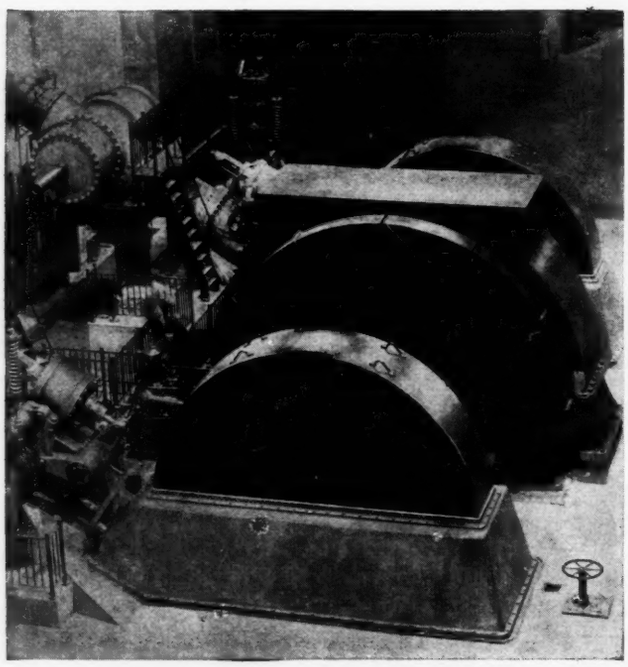


Fig. 7—This waterwheel operates under a 2,230-ft. head and develops 70,000 hp. maximum output

velocity of the water from the power nozzles is around 250 miles per hour.

In conclusion, the problems of corrosion and erosion of water-power machinery are economic. Preventive, rather than remedial, measures are preferable. So far no rustless iron or steel of cost comparable to our present every-day products have been produced, though more expensive alloys are available and should be used in special applications. If allowed to proceed unchecked corrosion will not only greatly increase the cost of maintenance, but will also possibly destroy the usefulness of the equipment long before its economic life has been realized.

Collection of rust tubercles in a penstock may greatly reduce its carrying capacity by decreasing the cross-section and increasing the friction. In a case on record the removal of some 22 tons of rust from a power penstock increased the output of the existing wheels 25 per cent—maintenance work well justified by the results.

Application of metallic coatings by dipping, roasting, electroplating or spraying is at present limited, due to initial cost and difficulty of maintenance. Paints and like coatings are most widely used except for surfaces in sliding contact, in which case rustless facings or liners are employed, and where possible all machined surfaces are kept covered with a light oil or grease.

Erosion can be prevented best by removing the silt and sand in settling basins. Where this is not possible, the equipment should be designed for easy replacement of parts subject to wear.

Equipment maintenance is usually determined by economic considerations based upon the investment justified to maintain the output and performance which otherwise would be lost by depreciation.

In cases where obsolescence is a factor, due to improvements in the art, it is usually possible to bring old equipment almost up to the efficiency of latest designs by relatively inexpensive alterations which quickly pay for themselves in increased performance.

The fight against corrosion begins immediately on manufacture and shipment of the finished equipment, and protection must be conscientious and continuous throughout the remainder of its useful working life.

Synchronous Motor Causes Exciter Failure

IT IS generally known that a high voltage is induced in the field of a synchronous motor at the instant of starting. This voltage decreases as the motor comes up to speed, becoming zero at synchronism. Where a motor's field winding is connected directly to the exciter, if one side of the circuit is open while the motor is being started the voltage induced in the field coils may break down the insulation of the exciter's armature.

A case of this kind occurred during grinding and undercutting the commutator of a direct-current generator driven by a synchronous motor. The field winding of the synchronous motor was excited from the direct-current machine, and when setting up for grinding, part of the brush arms of the direct-current machine were removed. Care was taken by the maintenance men to have some brushes of both polarities left in contact with the commutator. However, the brush-holder cross connections had been opened up in such a way that an open circuit existed, and the synchronous motor's field winding was no longer short circuited through the armature of the generator. When the armature was kicked over by applying voltage to the motor, a high voltage built up in the open-circuited field winding of the synchronous motor that went to ground through the insulation of the generator's commutating-field winding.

When a synchronous motor is operated even for an instant its field winding should be short circuited during starting. This is to prevent a high voltage being induced in the field winding, which may cause a breakdown of the insulation on this or any other winding to which the field coils may be connected.

It is general practice to have the field switch on a synchronous motor so arranged that the field coils cannot be open circuited. In one position of the switch the field coils are connected to the source of excitation. When the excitation source is disconnected by opening the switch the field coils are connected to a discharge resistance. The switch is so arranged that one circuit is closed before the other is broken. This prevents the field circuit's being opened by accident. Where the field coils are connected directly to the excitation source they are not intended to be disconnected.

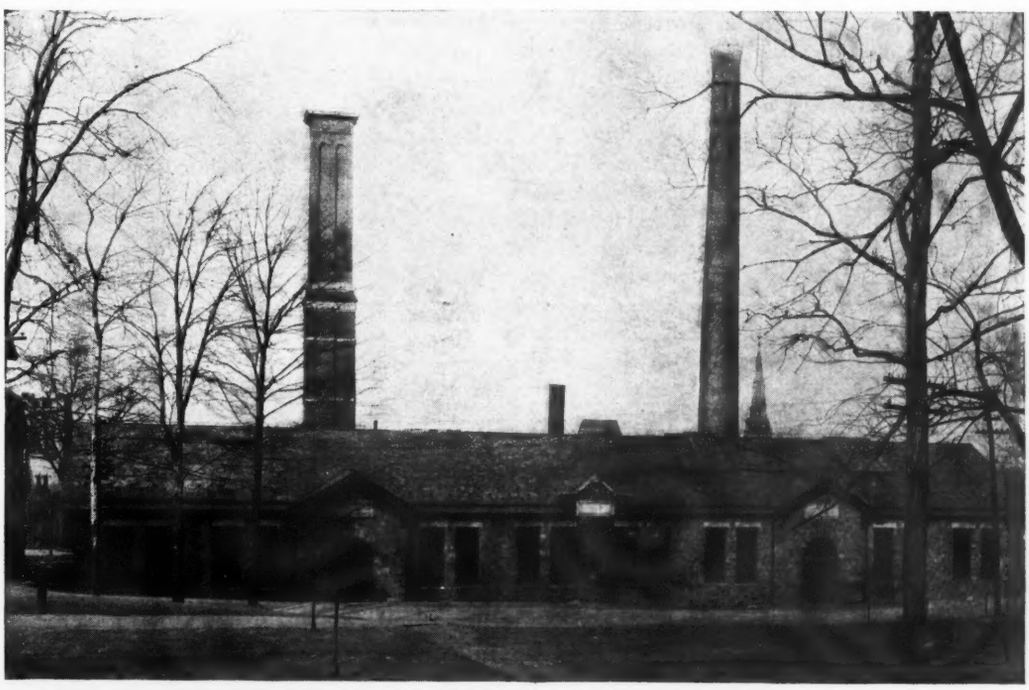
Ingenuity Saves Money In Rebuilding Lehigh's Heating Plant

Intelligent rehabilitation requires something more than a lot of new equipment. It involves weighing savings against first cost, item by item, for existing local conditions. This was done at Lehigh University, where the heating plant was rebuilt in four months—from steam to steam—at remarkably low cost.

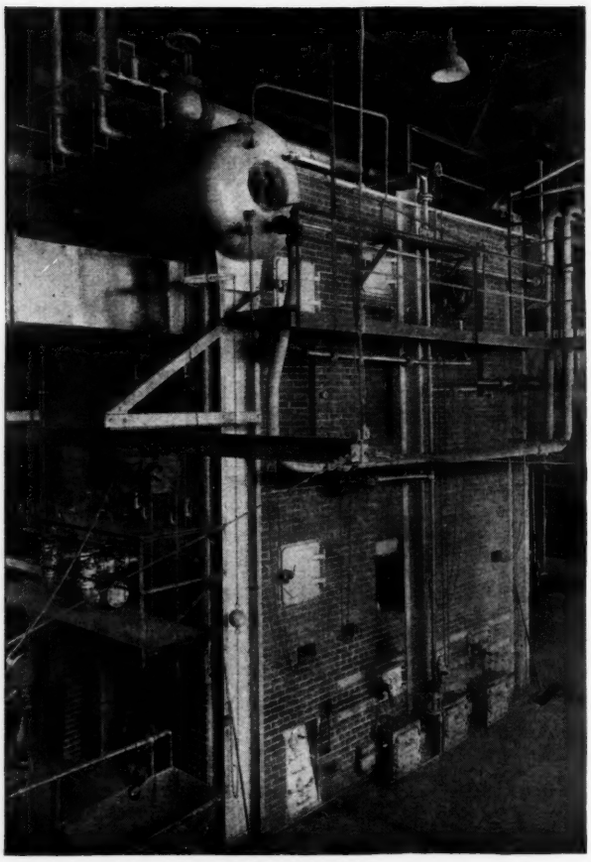
COMPLETE MODERNIZATION of a university heating plant for approximately $80,000 is a noteworthy feat even when due allowance is made for the decidedly favorable equipment prices frequently obtainable by educational institutions. This was accomplished at Lehigh University, Bethlehem, Pa. Except for the old building, stacks and a few odd pieces of equipment, which were retained in the rebuilt plant, the university obtained a completely new boiler plant for this sum.

New equipment included three 3,000-sq.ft. stoker-fired water-tube boilers, built for 250-lb., pressure, forced-draft fans, feed pumps, coal- and ash-handling equipment and a modern all-welded piping installation. In spite of favorable prices, this essentially new plant would have cost much more than $80,000 had it not been for close analysis of every item in terms of fixed charges and savings obtainable under existing conditions.

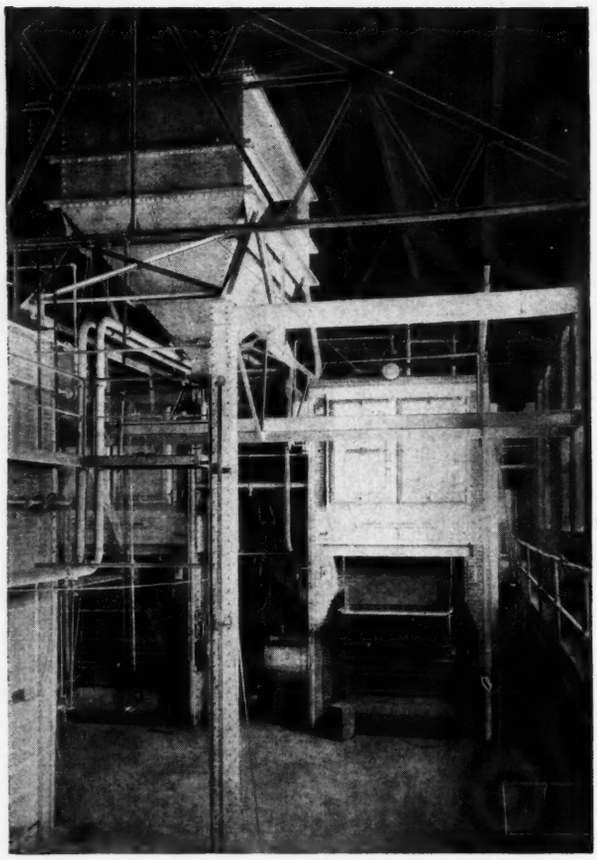
Another notable feature of this job, supervised by Prof. F. V. Larkin, head of the mechanical engineering department, with the assistance of Prof. M. C. Stuart, was the rapidity with which the rebuilding was accomplished. Steam from the old plant was on the lines until June 1, 1928. On Sept. 24 dormitories and class rooms were warmed with steam from the new plant. Only the "alums" who re-occupied the campus for a few days early in June had to put up with cold showers.



Inside this old building is a plant almost completely new



Ash-handling bucket and hoist are shown in the left foreground



The inside coal bunker feeds to a moveable weigh larry (not shown)

New equipment installed is summarized in the table on page 353 and illustrated, in part, by the accompanying photographs. An outstanding factor in keeping down reconstruction expenses was the exercise of ingenuity to make possible utilization of existing stacks and building. It was found unnecessary to raise the roof or alter the floor, beyond sinking pits for ash-handling pockets and running a trough the length of the boiler room floor to carry the forced-draft duct.

In 1928, with construction started on a new library and the million-dollar James Ward Packard laboratory of mechanical and electrical engineering, it became evident that the existing plant would soon be too small to heat the university buildings. The time was therefore opportune to replace the obsolete hand-fired boilers and much of the other equipment installed in 1907.

Since Bethlehem is near the center of anthracite mining, it was obvious that the new plant would operate most economically on No. 3 buckwheat, the smallest and cheapest commercial size of this fuel. This had a bearing on the alternate possibility of adding boiler capacity to the existing plant. The old boilers could not handle coal smaller than No. 1 buckwheat, while the new boilers, stoker-fired and equipped with forced-draft, could easily burn the much cheaper No. 3. Thus an enlargement of the old plant would have required simultaneous burning of both sizes of coal at an added operating cost over the use of No. 3 alone that would justify an additional investment of $100,000 in a new plant.

Chain-grate stokers of a type particularly suited to small sizes of anthracite were installed. These were equipped with forced-draft and with zoned draft control.

By close figuring it was found possible to get all of the piping under the existing roof trusses with a few inches to spare at the hand wheels of the highest valves. This eliminated the heavy expense of raising the roof. Simple suspension of the piping without anchorage at any point was decided upon after weighing the customary objections to this procedure. No trouble has been experienced with the system. Welding was adopted as the modern way to insure tightness without increased cost.

The old open feed-water heater was retained because it was found suitable for operation with the new plant.

For lack of inside space, and to keep down construction costs, an overhead bunker of only 25 tons' capacity was installed. Studies made by Professor Larkin showed that the additional rehandling of coal that this would occasion would cost less than the additional fixed charges on a larger bunker.

Further savings were made by the adoption of a coal tower of extremely simple design. Incidentally, the lower part of this tower was placed within the boiler room as a simple solution to the problem of protecting the outside from corrosion by stored coal.

A rubber belt takes coal from a truck hopper and delivers it to a bucket elevator in the coal tower. The latter discharges through valve-controlled chutes at the top either to the storage pile or to the weigh larry, which in turn feeds the stoker hoppers. The belt also serves to carry coal from hoppers beneath the storage pile and deliver it through the same bucket elevator and chute to the bunker. All coal-handling equipment is motor-operated.

The ash-handling system in this plant may seem ultra-simple, but it is the logical outcome of cost studies. A

large combination hand-car and bucket is lowered by a power-operated chain hoist to the concrete pit in front of the boiler ash-pit. The ashes, after wetting, are discharged by gravity into the bucket, which is then hoisted to the boiler room floor and wheeled to an hydraulic elevator, which lifts it twelve feet to the dumping platform outside the building.

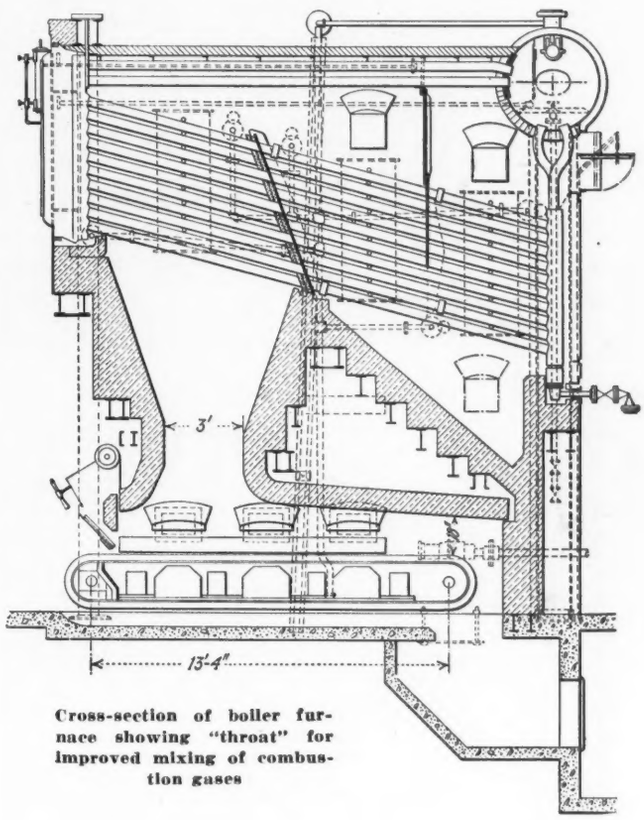
An overhead ash bin would be a paying investment in most plants. Here, however, contractors agreed to shovel and remove ashes from a ground pile for nothing, and offered only $125 yearly for the convenience of overhead storage with chute discharge to their trucks. Capitalization of this sum would not have covered the cost of an ash bunker.

Furnace Design Provides for Gas Mixing

The furnace design, while not unique, is of interest. As shown in the accompanying section of the boiler and furnace, low flat arches are suspended over the greater part of the fire to insure rapid ignition and combustion. The narrow "throat" below the upper combustion chamber insures thorough mixing and high CO_2 with complete combustion. It takes care of the inequalities of air distribution that are present even with zoned draft control.

Although now operated at 125 lb. pressure, the boilers are designed to carry 250 lb., which would make them available for future power generation and to meet any laboratory demand for steam at that pressure. The guarding of reliability is provided by duplicating feed heating mains to the new buildings operate at 125 lb. pressure. Steam for the old mains is reduced to 15 lb. at a near-by junction point.

Forced draft is supplied by either of two turbine-driven fans at the ends of the air duct. Guillotine dampers in this duct make it possible to supply any or all of the boilers from either of the fans. Additional safe-



Cross-section of boiler furnace showing "throat" for improved mixing of combustion gases

pumps and feed lines. This, incidentally, makes it possible to isolate any boiler for test purposes.

After being heated by auxiliary exhaust in an open heater, the feed water is delivered to the boiler by either of two duplex pumps. Feed is measured by an indicating meter of the displacement type. Steam also can be measured by flow meters.

Automatic Combustion Control

Automatic combustion control with balanced draft has been installed on one boiler and will soon be applied to the others.

The boilers are capable of continuous operation at 200 per cent of rating. With a fourth boiler, for which space has been provided, it is believed that this plant can supply the needs of the university for the next twenty years.

One decidedly unusual feature of the plant is a brook that runs under the boiler house and directly beneath the stokers of the two boilers. It is accommodated by a concrete sewer three feet square.

Another brook, 1,000 feet up the hill, supplies clear and soft make-up water in ample quantity.

Reports on Present-Day Russia are decidedly conflicting—black or white according to their source. Perhaps the day is not far distant when the hundreds of American engineers now working on the Russian economic program will be able, as trained impartial observers, to tell us what is really going on there.

Principal New Equipment in Lehigh Heating Plant

Boilers

Number	3
Manufacturer	Babcock & Wilcox Company
Type	Water-tube, cross-drum, 3-pass
Heating surface, each, sq.ft.	3,000
Arches	M. H. Detrick Co.
Brickwork	McAleenan Corporation

Stokers

Type	Coxe, chain-grate, zoned air supply
Manufacturer	Combustion Engineering Corporation
Grate surface, sq.ft.	82
Drive, one engine per stoker	Clarage Fan Co.

Draft Equipment

Forced-draft fans	B. F. Sturtevant Co.
Number	2
Type	Turbovane, turbine-driven
Breeching	Allentown Boiler Works

Combustion Control

Number (3 ultimate), installed	1
Manufacturer	Engineer Co.

Coal-Handling Equipment

Manufacturer	C. O. Bartlett & Snow Co.
Elements: belt conveyor, bucket elevator, coal tower, weigh larry, overhead bunker (25 tons capacity)	

Feed Water

Feed pumps, number	2
Type	Duplex
Manufacturer	Worthington Pump & Machinery Corp.
Feed-water meter	Positive-displacement type
Manufacturer	Detroit Meter Co.

Piping

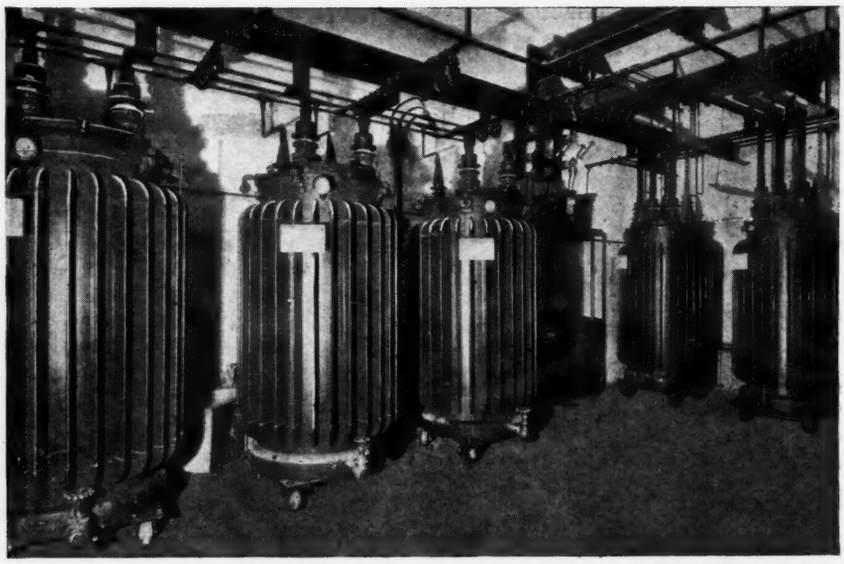
Method of fabrication	By welding
High-pressure piping contractor	Charles M. Brown Co.
Pipe covering contractor (Johns Manville, 85 per cent Magnesia)	Nicely & Co.
Valves	Crane Co.

Boiler Equipment

Feed-water regulators	Copes, Northern Equipment Co.
Soot blowers	Diamond, Power Specialty Corp.
Blowoff valves	A. W. Cadman Mfg. Co.
Safety valves	Consolidated Ashcroft Hancock Co.
Non-return valves	Golden Anderson Valve Specialty Co.

Other Equipment

Ash Hoist (Low head, electric)	American Engineering Co.



Two banks of transformers in a large office building

Periodic Care of TRANSFORMERS

Cuts Maintenance Costs

Engineers who inspect and maintain their transformers on a regular schedule know that the practice pays dividends in improved service and reduced repair costs. This article deals with the faults that may develop in transformers and how to remedy them. A second article will outline simple tests that may be applied to transformers to determine their condition.

By A. A. FREDERICKS
New York City

CONVENTIONAL-TYPE transformers are such simple pieces of equipment and require so little attention that users are likely to forget about them. This is a sure way of getting into unexpected trouble. Transformers, although they may operate for years without attention, need periodic inspection to insure reliable service. Even though a transformer may have no moving parts and is immersed in oil, a lot of things can happen to interfere with its satisfactory performance.

Frequency of inspection varies widely with the type and size of transformer, its loading and location. For small, oil-insulated, self-cooled distribution transformers, every two years may be often enough to make inspections, particularly if the load is not likely to increase. Large transformers should be inspected more frequently. Some operators recommend that the oil in larger water-cooled transformers be tested every month.

In instructions for the care and operation of transformers of the National Electric Manufacturers Association (N.E.M.A.) recommendations are made that power transformers should be taken out of service and thoroughly inspected at least once a year. The inside of the cover and the tank above the oil should be regularly looked over to see that the surfaces are clean, dry and free from moisture and that the thermometer bulb is clean. If an appreciable amount of dirt and sediment is found inside the tank it is best to take out the transformer and remove the oil. The transformer and tank should then be cleaned and the oil filtered and tested. Only dry cloths or waste should be used for cleaning. Care should be taken to see that all nuts are tight and all parts are in their proper places. If the transformer is water-cooled the cooling coils should be cleaned thoroughly. After the transformer and oil are put into the tank and the cover is in place, all cracks and openings should be closed tightly.

A good practice is to make two checks a year on distribution transformers. In one of these, determine the condition of all external connections, the bushings, wiring, ground connections, lightning arresters and fuses. Also check the oil level, which, if found low, should be corrected by adding new oil. Better still, give the transformer a thorough inspection. Take it out of service and remove the oil, and if the coils are fouled with sludge they should be thoroughly cleaned and the case filled to the proper level with dry oil.

A careful check should be made to detect any oil leaks from the tank. Oil may leak from the tank around the threads of plugs, drain cocks, gage glasses and other connections and through joints and may be syphoned out along the leads. Threaded joints can usually be put in good condition by opening them and cleaning the threads with a die and a tap. Before making up the joint again, cover the threads with thick shellac, litharge and glycerine or white lead. After making the joints, they should be allowed to thoroughly dry before putting oil in the tank.

If the leads are oil-soaked, due to oil syphoning from the tank, replace them with new ones. The outlet leads must be soldered to the coil leads above the oil level and their strands sweated solidly together for two or three inches to prevent the oil from syphoning out between the strands. The joint is then taped with varnished cambric, which is extended well up on the outlet lead (see Fig. 3).

A second annual check made on transformers is for loading. This test should be made for a period of 24 or 48 hr. at least. Ammeters should be connected in each outside leg of the circuit to determine the value of the load and how it is distributed on each winding. The load should be kept nearly balanced on the different windings and should not exceed the rating of the transformer. It is also advisable to check the voltage between the different leads. If found very much out of balance, effort should be made to correct the fault. If a watt meter is used, the power factor must also be determined to obtain the kilovolt-ampere load. The load a transformer can safely carry is determined by the kilovolt-ampere output, not kilowatts. A 10-kva. transformer will have about the same temperature when supplying a 7.5-kw., 0.75-power-factor load as when supplying 10 kw. at unity power factor. In both cases the current is the same and current determines the heating of the windings.

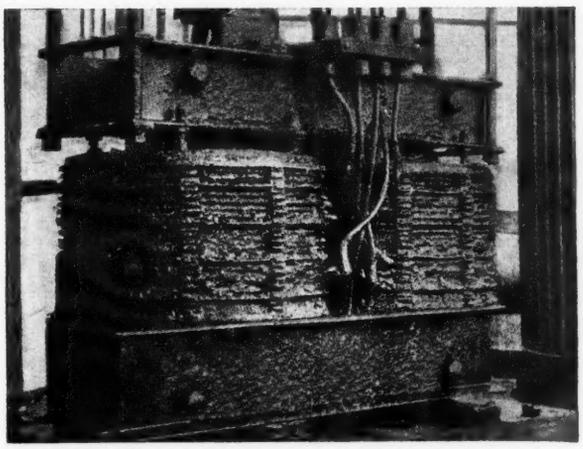


Fig. 1—Oil Sludge on transformer coils causes excessive temperatures

Transformers should be kept properly fused, or if circuit breakers are used they should be adjusted to give protection against excessive overloads. Table I gives the size of primary fuses used by one company on 2,300-volt transformers, and Table II the fuse sizes for 4,000-volt transformers. The cause of fuses blowing may be a lightning surge, a flashover on a bushing, or on a terminal block inside the transformer, and short circuits on the secondary line. Most of these faults are difficult to locate, as the cause is removed when the trouble clears. If oil is allowed to deteriorate, dirt is likely to collect on the terminal block under the oil's surface in the transformer and cause a flashover. When this happens the fuse blows and the arc may be extinguished before serious damage is done. Allowing the oil level to become so low as to expose the terminal block may also result in flashovers that will blow the fuses.

Overheating is one of the chief faults experienced in transformer operation. Self-cooled transformers depend entirely upon the surrounding air to carry away the heat produced inside them. For this reason they should be installed where there is free air circulation. In vaults or other out-of-the-way places, if their temperature cannot be maintained within safe limits by natural air circulation, forced ventilation must be used.

Oil must be kept at the proper level and in good condition, and coils must be kept clean to allow a free circulation of oil around them, or the temperature will become abnormal. Figs. 1 and 2 give a good idea of the way transformer coils may become sludged if they are neglected. When such conditions exist, the ducts between the coils are clogged so that the oil cannot circulate and the winding temperature becomes excessive. If transformers are allowed to operate this way for long periods, even at less than rated load, the winding insulation is likely to be destroyed. In some cases when the insulation did not fail when the transformers were in service it was found impossible to clean the windings and the transformers were junked.

When insulation is in good condition and sludging is not excessive, the winding may be cleaned by first scraping off the dirt and sludge. A slender brush with a long handle may be used to clean the oil ducts between coils. After that has been done, insulating oil under pressure should be used for the final cleaning. A jet of oil should be forced through the ducts until they are thoroughly cleared. The transformer is then put back into its case, which is filled to the proper level with oil that is known to have high dielectric strength.

Sludging of transformer oil may not change its dielectric strength, but it will change its heat-dissipating qualities. If the temperature of transformer oil is allowed to become too high, excessive sludging, syphoning and vaporizing of the oil will result. The top oil temperature

Fig. 2—Excessive sludging occurs on the coils if they are neglected

should not be allowed to exceed 85 deg. C. (185 deg. F.).

If the temperature of a self-cooled transformer is found to be getting into the danger zone, it probably can be reduced by using three or four desk fans to blow air over the surface of the tank. The air should be so directed as to flow from the bottom to the top of the tank. Water jets directed onto the tank have also been used successfully. Fig. 4 shows one method of doing this. Holes about $\frac{1}{16}$ in. diameter and 3 in. apart are bored in a $\frac{1}{2}$- or $\frac{3}{4}$-in. pipe, which is then bent, with the holes on the inside, to fit around the tank. This pipe is supported near the top of the transformer, as in the

TABLE I—PRIMARY-FUSE SIZES FOR 2,300-VOLT DISTRIBUTION TRANSFORMERS

Kva. Rating	Full Load, Amperes	Fuse Size, Amperes	Kva. Rating	Full Load, Amperes	Fuse Size, Amperes
1.5	0.65	5	25	10.9	50
3	1.30	5	37.5	16.3	70
5	2.2	10	50	21.8	80
7.5	3.3	15	75	32.6	130
10	4.3	20	100	43.5	180
15	6.5	25	150	65	} Circuit
....	....	..	200	87	} breaker

TABLE II—PRIMARY-FUSE SIZES FOR 4,000-VOLT DISTRIBUTION TRANSFORMERS

Kva. Rating	Full Load, Amperes	Fuse Size, Amperes	Kva. Rating	Full Load, Amperes	Fuse Size, Amperes
1.5	0.375	5	25	6.25	30
3	0.75	5	37.5	9.38	40
5	1.25	5	50	12.25	50
7.5	1.875	10	75	18.75	80
10	2.5	10	100	25	100
15	3.75	15	150	37.5	150
....	....	..	200	50	200

figure, and connected to a source of water supply. Such an expedient should be considered only as a means of meeting an emergency to keep the transformer's temperature within safe limits.

A common cause of water-cooled transformers overheating is fouled cooling coils. These coils become fouled in two ways: (1) vegetable and other matter collects in the coils and retards the flow of the cooling water; (2) scale is formed on the inside of the coils by calcium carbonate or other scale-forming matter in the water.

In the first case, the coils can usually be cleaned with compressed air or high-pressure water. A high-pressure hand pump may be used to force the water through the coils. Pressures of 200 to 300 lb. may be required to force the dirt out.

A solution of hydrochloric acid and water may be used to remove scale from inside the coils. The instructions of N.E.M.A., previously referred to, recommend a solution of equal parts of commercially pure concentrated hydrochloric acid and water. Both inlet and outlet water pipes should be disconnected and the cooling coils temporarily piped away from the transformer, where they can be filled and emptied safely. Special care must be taken to prevent any acid, dirt or water from getting into the transformer.

It may be found necessary to force the solution into the coils. When this is done one end of the coils should be partially restricted so that the solution will not be wasted when the coils are full. After the solution has stood in the coils for about an hour, they should be flushed out thoroughly with clean water. If all the scale is not removed the first time, the operation should be repeated until the coils are clean, using new solution each time. The number of times it is necessary to repeat the process will depend upon the coils' condition; ordinarily, one or two fillings should be sufficient.

As the chemical action between the solution and the scale may be violent and may force acid and sediment from the coils, it is advisable to leave both ends partially open to prevent abnormal pressures.

A solution made of $\frac{1}{2}$ lb. of sal soda (ordinary washing soda) per gallon of hot water is used by some operating engineers for cleaning cooling coils. They are filled with the hot solution and it is allowed to remain for about 15 min., after which they are drained and flushed with clean water. If this treatment does not thoroughly clean the coils a weak hydrochloric acid solution is used to complete the work. The latter is made in the proportions of one pint of acid to $1\frac{1}{2}$ gal. of cold water. It is allowed to remain in the coils for about 15 min.; then the coils are thoroughly flushed out with clean water.

A method of using compressed air for filling the coils with solution is indicated in Fig. 5. The pressure tank is made from an oil drum or similar container and is equipped as indicated. The receiving tank is an open container located above the pressure tank. To start operation, the solution is put into the receiving tank, valves *A* and *B* are opened and the pressure tank is filled up to near the top of the gage glass. Valves *A* and *B* are then closed and air valve *C* opened sufficiently to maintain a pressure in the tank that will cause the solution to flow slowly through the coils into the receiving tank. When the receiving tank is nearly full or the pressure tank empty, air valve *C* is closed and *B* opened. After the pressure in the tank has been reduced to zero, valve *A* is opened, the pressure tank is filled and the solution again passed through the cooling coils. When the coils are clean, the air pressure is left on until the coils have been blown dry. The coils may then be connected into the cooling-water system to wash out any acid solution that may remain in them. This method of cleaning is adaptable to many arrangements, depending upon the local conditions and the ingenuity of those applying it.

Where the transformer has more than one cooling coil, some operating engineers arrange to clean them without taking the transformer out of service. One coil is

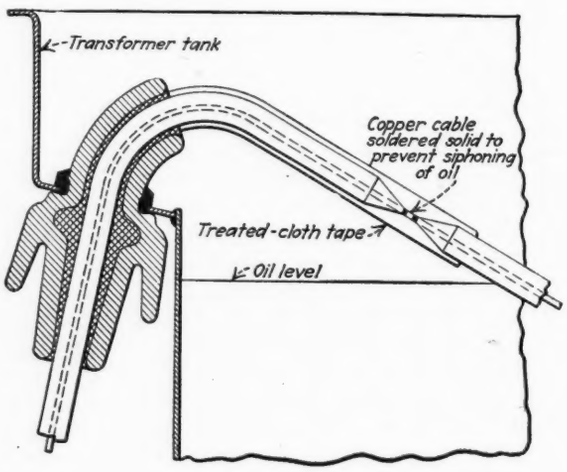


Fig. 3—Lead joint made so as to prevent oil syphoning

cleaned at a time and the work is done during light-load periods. Instead of filling with the acid solution and allowing it to remain for a time before flushing, the solution is circulated through the coil, as previously explained. In a method employed by one operator a wooden barrel is used to hold the solution, which is

circulated by a pump. The intake of the pump is connected near the bottom of the barrel and its discharge to the intake end of the coil. The discharge of the coil is piped back into the barrel. A 10 per cent solution of hydrochloric acid and water is used, which is kept circulating slowly through the coil by the pump. How the cleaning is progressing will be indicated by the amount of foam and sediment coming from the coil. Since the solution's action on the scale will neutralize the acid it may be necessary to add more acid as the work

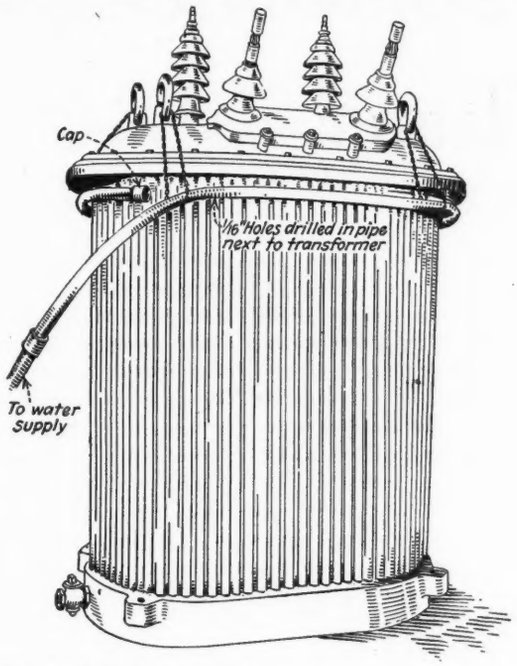


Fig. 4—Method of spraying water on transformer tank to keep down the oil temperature

progresses. After a coil is cleaned it is thoroughly flushed out with water and put back into service, and another coil is cleaned.

The circulating water is likely to get hard in a cooling tower, and give trouble by forming scale in the cooling coils. Treating the water chemically to neutralize the scale-forming properties may be advisable in such cases.

Sludge from the oil may form on the outside of the cooling coils. This will interfere with free transfer of heat from the oil to the cooling coils and the water, consequently the temperature of the oil may be excessively high when other conditions about the transformer are normal. To clean sludge from cooling coils, the transformer and oil have to be removed from the tank, if the coils cannot be removed with the cover. The sludge is scraped or brushed from the coils and their surfaces are washed with insulating oil or gasoline.

Transformer oil expands and contracts with changes in temperature. This causes the transformer to breathe. Chloride of lime breathers are used to remove the moisture from the air entering the transformer. Breathers should be watched carefully and the chloride of lime replaced before it becomes saturated with moisture, for in that event the chloride of lime would aid moisture's getting in the transformer instead of keeping it out.

Where the connection is small between the conservator and the transformer tank there is danger of the oil congealing in the connection if the transformer is taken out of service and allowed to stand in a low temperature. When the transformer is again put into service the congealed oil in the connection will not allow free oil flow between the transformer and the conservator. This may cause a pressure to build up in the transformer tank that will result in gasket leaks. A space heater placed on the connection between the two tanks and wrapped with asbestos, has been used successfully to overcome this trouble. The heater is only switched on when the transformer is out of service. Or the heater may be connected to the line a short time before the transformer is put into operation.

Air-blast transformers depend upon free circulation of air, at about one ounce pressure, to carry away the heat produced in the windings. When ventilating ducts become restricted with dirt the flow of air is hindered and winding temperature increases. When the difference in temperature between inlet and outlet air at normal load exceeds 15 deg. C. (59 deg. F.) it indicates that the transformer is not getting sufficient air. This may be caused by the dampers being partly closed, the speed of the fan being low or the air ducts between the coils being restricted with dirt.

The air ducts should be cleaned at least once a month on an air-blast transformer. If the cooling air has a high dust content, more frequent cleaning may be necessary. In some plants it is the practice to clean air-blast transformers each day, but these are located where dust content in the atmosphere is exceptionally high. Air ducts between coils should be cleaned with a felt swab, where this is possible, and the outside parts brushed. After this has been done, dry compressed air at about 20-lb. pressure is applied to complete the cleaning. The air should be blown from the bottom toward the top of the coils, so that the dust will be carried out of the transformer.

Care should be taken not to let small metal parts fall into the tank or windings. If loose metal is left in the transformer when it is assembled or inspected it is likely to cause a breakdown.

A little care in the operation of transformers will go

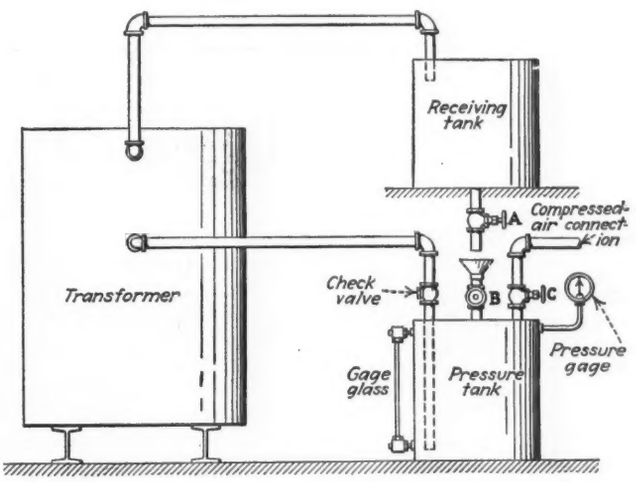


Fig. 5—System of filling transformer cooling coils with cleaning solution

a long way toward obtaining 100 per cent service. This has been proved in many cases where transformers were neglected. During the period of neglect breakdowns were common. Then a system of regular inspection was introduced that in a short time practically eliminated troubles and greatly reduced the cost of maintenance.

Dividing Heating Surface Among Boiler, Economizer and Air Heater

By LINN HELANDER
Mechanical Engineer, Philadelphia, Pa.

MY PURPOSE is to suggest formulas for simplifying the work of apportioning boiler, economizer and air heater surfaces, and to illustrate how they may be used to gage the effect that changing either the steam pressure or the feed-water temperature has upon the economic efficiency of the boiler plant. No attempt is made to solve practical problems, but examples are given to illustrate the direction of the influence of changed conditions on the economic efficiency of steam generation.

It will be obvious from the discussion that when economizers are employed an elevation of the feed-water temperature is accompanied by a depression of the efficiency of the boiler plant which cannot be remedied economically by the use of additional air-preheating surface. When economizers are not employed, a like effect is produced by an elevation of the steam pressure. The economic efficiency of the boiler plant is furthermore lowered by an increase in the cost of adding boiler, economizer or air-preheating surfaces.

Of course, under specific conditions, considerations other than the economics of apportioning surfaces (such as a desire to prevent sweating) may determine the low limit of the temperature of the gases out of the air heater. In such cases the efficiency of steam generation may be the same regardless of steam pressure or feed-water temperature.

One case was considered, using approximately correct heat transfer rates and cost data. This was the case of a Calumet boiler equipped with large economizers and air preheaters. The temperature of the gases out of this boiler was fixed by its design and superheater, and there-

DATA ON RECENT HIGH-

	Initial Stm. Press.	Initial Stm. Temp.	Reheat Temp.	Fuel Burning Equipment	No. of H.P. Boilers	Boiler Surface per Boiler			Economizer Surface per Boiler			Air Heater Surface per Boiler		
	Lb. per Sq.In. Gage	Deg. F.	Deg. F			Sq.Ft.	Type of Boiler	Boiler Surface in % Total*	Sq.Ft.	Type of Economizer	Per Cent of Boiler Surface	Sq.Ft.	Type	Per Cent of Boiler Surface
1—Deepwater Station, Deepwater Point, N. J., A. G. & E. and U. G. I.	1,400	725	750	Pulv. Fuel Comb. and B. & W.	4	9,000	B. & W. C.D.	13.1	18,326	B. & W. steaming	207	42,693	Plate	475
2—Deepwater Station, Deepwater Point, N. J., A. G. & E. and U. G. I.	1,400	725	750		2	9,000	B. & W. C.D. Reheat	10.1	4,765	B. & W.	53	42,693	Plate	475
3—State Line Station, Hammond, Ind. State Line Generator Co.	Boiler built for 800 lb. Turbine throttle pressure 650 lb.	Superheater outlet 750 Turbine throttle 730	500	Pulv. fuel B. & W.	5	10,294	B. & W. C.D.	10.5	19,820	B. & W. steaming	193	56,401	Tubular	549
4—Holland Station, New Jersey Power & Light Co.	1,400	750	750	Pulv. fuel Comb.	2	7,928	B. & W. C.D. Reheat	11.2	11,880	Foster Wheeler	150	32,450	Plate	410
5—Edgar Station, The Edison Elec. Illuminating Co. of Boston, Boiler No. 3.	1,200	707	700	Taylor Stoker	1	15,732	B. & W. C.D.	44.0	11,091	B. & W.	70	None	.....	0
6—Edgar Station, The Edison Elec. Illuminating Co. of Boston, Boiler Nos. 5 and 6	1,400	725	750	Taylor Stoker	2	15,093	B. & W. C.D.	22.4	5,596	B. & W.	37	33,092	Tubular	220
7—Edgar Station, The Edison Elec. Illuminating Co. of Boston, Boiler Nos. 7 and 8	1,400	725	750	Taylor Stoker	2	6,971	B. & W. C.D.	11.9	9,634	B. & W.	138	29,665	Tubular	425
8—Lakeside Station, The Milwaukee Elec. Rwy. & Light Co., Milwaukee.	1,265	730	450 in 710 out	Pulv. Fuel Lopulco	1	28,532	B. & W. Stirling Reheat	29.1	None	.....	0	66,942	Plate	235
9—Northeast Station, Kansas City, Mo.	1,400	725	700	Pulv. Fuel Lopulco	2	16,950	Ladd	23.0	10,891	Comb. Fin tube	64	39,270	Plate	232

Note:—*Exclusive of live-steam reheater surface.

fore was not subject to adjustment in accordance with the economics of apportioning surfaces. For a steam pressure of 450 lb. this temperature was 1,100 deg. F., and for a pressure of 1,400 lb. it was 1,250 deg. With

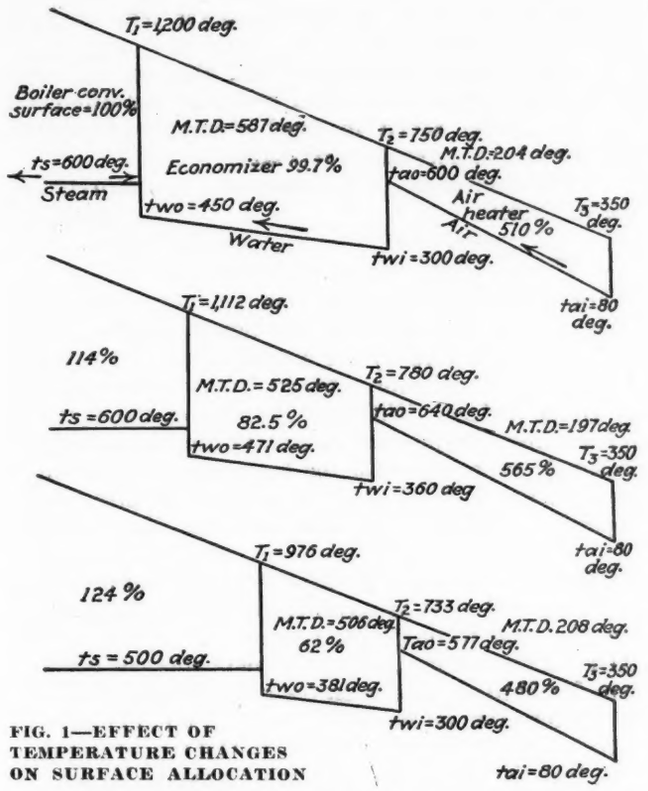


FIG. 1—EFFECT OF TEMPERATURE CHANGES ON SURFACE ALLOCATION

The diagrams are intended merely to show the directional influence, on the allocation of the convection surface, of changing steam and feed-water temperatures. The basic data on heat transfer rates and cost of surface were arbitrarily selected and do not represent practice. The final flue-gas temperature was assumed constant.

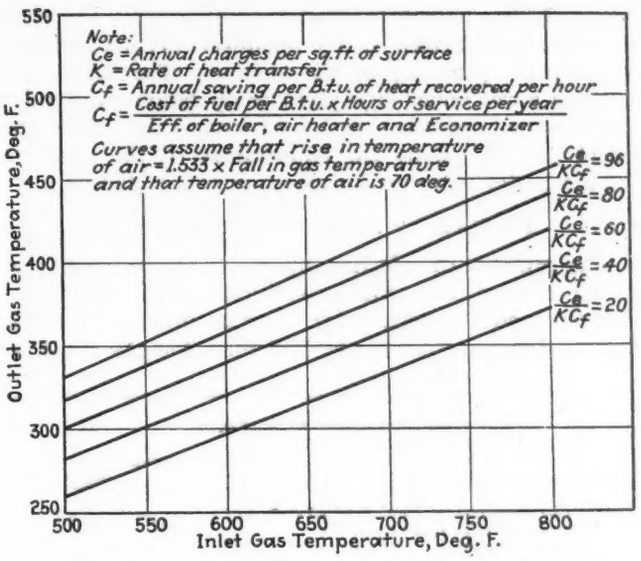

Note:
Ce = Annual charges per sq.ft. of surface
K = Rate of heat transfer
Cf = Annual saving per B.t.u. of heat recovered per hour
Cf = Cost of fuel per B.t.u. x Hours of service per year / Eff. of boiler, air heater and Economizer
Curves assume that rise in temperature of air = 1.533 x Fall in gas temperature and that temperature of air is 70 deg.
Ce/KCf = 96
Ce/KCf = 80
Ce/KCf = 60
Ce/KCf = 40
Ce/KCf = 20
Outlet Gas Temperature, Deg. F.
Inlet Gas Temperature, Deg. F.
550
500
450
400
350
300
250
500
550
600
650
700
750
800

Fig. 2—Optimum temperature of gas out of air heater, for various inlet gas temperatures

these temperatures established and a feed-water temperature of 350 deg., the economic final flue-gas temperature was 222 deg. with a steam pressure of 450 lb., and 224 deg. with a steam pressure of 1,400 lb. The difference between these temperatures is obviously negligible.

When the temperature of the feed water was raised to 430 deg., the economic final gas temperature was increased by 23 deg. When the economizers were omitted and additional air heater surface, but no additional boiler surface, was employed, the economic final gas temperature was increased to 387 deg. with a steam pressure of 450 lb., and to 424 deg. with a steam pressure of 1,400 lb. These latter temperatures are higher than they would be in a practical case, for there the economizers would not be omitted except with an in-

PRESSURE POWER PROJECTS

Reheat Surface Per Boiler			Superheater Surface Per Boiler		Water Walls Per Boiler		Final Gas Temp.	Final Air Temp.	Steam Cap. Lb. per Hr. per Boiler	Prime Mover Data		Total Capacity Served By H.P. Boilers
Sq.Ft.	Type	Per Cent. of Boiler Surface	Sq.Ft.	Type	Sq.Ft.	Type				Make	Capacity	
None	.....	0	Data not available		2,755 in 3 boilers 2,540 in 3 boilers	Bailey Mainly Bare tubes	325	464	331,000	G.E.	2-58,000-kw. cond. units; 1-12,500-kw. non condensing unit	128,500 kw. with ability to supply 530,000 lb. of process stm. at 400 lb. press.
23,562	Convect.	262	Data not available				325	456	290,000	G.E.		
Live steam reheater Ext. tube surface 17,980 Internal surface 15,100			7,200	Convect.	4,090	Bailey	at 450, evap. 394	000 lbs rate 521	450,000	G.E.	1-208,000-kw. 1-hp. element 76,000-kw. 2-l.p. element 62,000-kw. each 2-house generators 4,000-kw. each	208,000 kw.
11,400 plus 1,508	Convect. and steam	144 plus 19	5,500	Convect.	1,600	Comb:	325	400	250,000	G.E.	55,000-kw.	55,000 kw.
5,938	Convect.	38	2,923	Convect.	None	.....	379	.....	143,000	G.E.	H.P. elements 1-3,150 kw. 1-10,000-kw. 1-12,500-kw. 400 lb. elements 2-32,000 kw. 1-65,000 kw.	18,800 kw. of which 3,150 kw. is H.P. and 15,650 is share of 400 lb. load.
8,879	Convect.	59	3,483	Convect.	1,235	Bailey	339	401	225,000	G.E.		87,500 kw. of which 22,500 kw. is at 1,400 lb. and 65,000 kw. is at 400 lb.
6,936	Convect.	100	4,021	Convect.	1,206	Bailey	352	454	250,000	G.E.		
933	Radiant	03.3	930	Radiant	1,544	Fin and plain tube	350	660	240,000 normal	G.E.	7,000 kw.	31,000 kw.
940	Radiant	5.5	2,650	Convect.	3,050	Fin and plain tubes	328	412	170,000 normal	West.	10,000 kw.	42,300 kw. of which 10,000 kw. is at 1,400 lb and 32,300 kw. at 290 lb.

crease in the amount of boiler surface used, but they illustrate the fact that when economizers are not included in the boiler plant layout, the economic efficiency of the latter is lower under high-pressure operation than under low-pressure operation, and furthermore they show the effect that increasing the temperature of the gases at the air heater entrance has upon economic efficiency.

Problem of Apportioning Surface

The problem of selecting the most advantageous size of air heaters, and, when conditions justify their use, the most advantageous size of economizers, involves, first, a determination of the best final flue-gas temperature, and, second, a determination of the best division of work between the boiler and the air heater, or the boiler, the air heater, and the economizer, if all three are used.

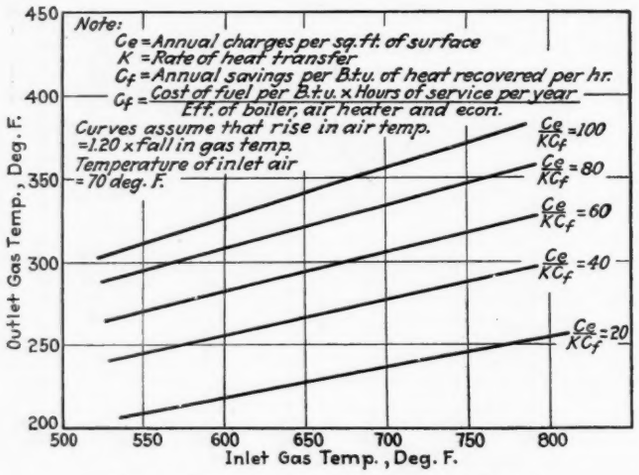

Note:
Ce = Annual charges per sq.ft. of surface
K = Rate of heat transfer
Cf = Annual savings per B.t.u. of heat recovered per hr.
Cf = Cost of fuel per B.t.u. x Hours of service per year / Eff. of boiler, air heater and econ.
Curves assume that rise in air temp. = 1.20 x fall in gas temp.
Temperature of inlet air = 70 deg. F.
Ce/KCf = 100
Ce/KCf = 80
Ce/KCf = 60
Ce/KCf = 40
Ce/KCf = 20
Outlet Gas Temp., Deg. F.
Inlet Gas Temp., Deg. F.
450
400
350
300
250
200
500
550
600
650
700
750
800

Fig. 3—Same as Fig. 2, except for different conditions, as noted

In moderate-pressure plants, economizers usually can be profitably dispensed with, the problem becoming one simply of determining the best ratio of air-heating surface to boiler surface. This has been discussed by various writers, but only under the assumption that the temperature of the gases to the air heater is one of the fixed conditions. This assumption leads to a partial solution only, for the temperature of the gases to the air heater under the condition of a constant evaporation is itself a function of the size of the boiler and therefore a variable.

In high-pressure plants, and, under certain conditions, in moderate-pressure plants, economizers may be used in combination with air heaters to reduce construction costs. The inclusion of an economizer in the steam-generating system in this manner further complicates the problem of economically proportioning the various surfaces. In the case of a boiler plus an air heater, a solution can be obtained by comparing the probable economies of various layouts, although this is likely to prove a long process. In the case of a boiler plus an economizer plus an air heater, the large number of possible combinations makes the use of this method impracticable. Fortunately, simple formulas may be developed which shorten the work involved in either case.

Except for the influence of special local conditions and the limited adaptability of equipment, principal factors that determine the economical proportions of air heater, economizer, and boiler convection surfaces are:

1. The station heat balance in so far as it fixes steam, air, gas and water temperatures, and gas, air, and water quantities.
2. The heat-transfer rates applying to each of the surfaces.
3. The unit cost of increments of each kind of surface.
4. The power required to overcome the resistance offered by each kind of surface to the flow of fluids heated and cooled.
5. The rate of depreciation and the cost of maintenance of each kind of surface and whatever differential factor may be added to fixed charges by operators because of the uncertainty of data.
6. The equivalent steam value of heat recovered by the air heater.
7. The cost of fuel.
8. The capacity factor.

For the purpose of determining the most advantageous division between economizer, air heater, and boiler surfaces, heat absorbed by the air heater may be regarded as equivalent, unit for unit, to heat absorbed directly by boiler surface. With this assumption, the equations for increment savings and increment capital charges lead to simple expressions for the best economic division of these surfaces. Formulas thus derived are given in the appendix, together with examples that illustrate their use.

These formulas indicate preferred temperatures at the entrances and exits of economizers and air heaters, and may be used to guide the selection of layouts. They show, on the one hand, the preferred outlet-gas temperature for fixed conditions on the gas-entrance side of the air heater, and, on the other, the best division of work between the boiler, the economizer, and the air heater.

A tentative final flue-gas temperature may be assumed and then checked when the temperature of the gases entering the air heater is established, or the equations may be solved graphically, as is done in Fig. 4. The unit costs of increments of the various surfaces should be used in the formulas, and designs should be compared, in one case omitting the air heater, and in the other the economizer.

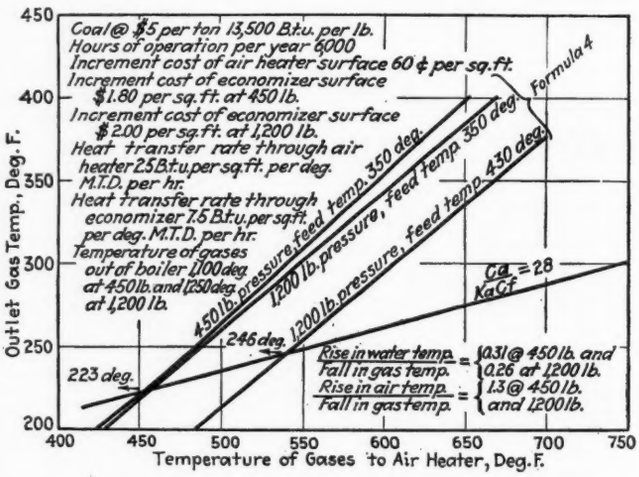

Coal @ $5 per ton 13,500 B.t.u. per lb.
Hours of operation per year 6000
Increment cost of air heater surface 60 ¢ per sq.ft.
Increment cost of economizer surface $1.80 per sq.ft. at 450 lb.
Increment cost of economizer surface $2.00 per sq.ft. at 1,200 lb.
Heat transfer rate through air heater 2.5 B.t.u. per sq.ft. per deg. M.T.D. per hr.
Heat transfer rate through economizer 7.5 B.t.u. per sq.ft. per deg. M.T.D. per hr.
Temperature of gases out of boiler 1,100 deg. at 450 lb. and 1250 deg. at 1,200 lb.
Formula 4
450 lb. pressure, feed temp. 350 deg.
1200 lb. pressure, feed temp. 350 deg.
1200 lb. pressure, feed temp. 430 deg.
Ca/KaCf = 2.8
246 deg.
223 deg.
Rise in water temp. / Fall in gas temp. = 0.31 @ 450 lb. and 0.26 at 1200 lb.
Rise in air temp. / Fall in gas temp. = 1.3 @ 450 lb. and 1200 lb.
Outlet Gas Temp., Deg. F.
Temperature of Gases to Air Heater, Deg. F.
450
400
350
300
250
200
400
450
500
550
600
650
700
750

Fig. 4—Graphical determination of optimum temperatures for gases out of air heater and economizer when both are used.

The temperatures indicated by the formulas are ideal and should be modified to fit the practical needs of any situation. In stoker-fired plants, for example, when the temperature of the air for combustion exceeds 350 deg. difficulties may be experienced; therefore, some oper-

ators will prefer to limit the amount of air preheat to this temperature. Also, the temperature of surfaces in air heaters made of ordinary steel plates or tubes should not much exceed 800 deg.; as a result the temperature of the entering flue gases is usually limited to approximately that temperature.

Fig. 1 illustrates the influence of the station heat balance on the preferred division of economizer, air heater, and boiler surfaces. Temperatures of feed water, air, and saturated steam enter into the equations for mean temperature differences and thus affect this division. As the saturated-steam temperature is increased the temperature head available for the transference of heat is reduced. This effect is felt particularly in the boiler convection zone.

Economic studies in respect to high-pressure steam generation therefore lead to a replacement of boiler convection surface by air heater or economizer surface, and to the use of relatively large economizers and air heaters. Large economizers are furthermore favored in high-pressure plants by the wide spread between the steam and the feed-water temperatures, and air heaters are favored by the wide difference in cost between boiler and air heater surfaces.

That these factors are practical influences will be seen in the use that 1,200-lb. plants are making of large economizers and large air heaters. Deepwater station, probably the most comprehensive of the 1,200-lb. developments under way, will have in the boilers, for example, only 12 per cent of the total surface used, the rest being principally in economizers and air preheaters.

Consideration should be given to the effect of economizers on the economical heat rate of turbines using regenerative cycles. Obviously, an increase in the temperature of the water fed to the economizers will produce a proportional increase in the temperature of the flue gases delivered to the air heater. This effect can be compensated for by the addition of an amount of air heater surface sufficient to maintain the exit flue-gas temperature unchanged. This addition of surface, however, should be justified on economic grounds, and a study of Formula 1 of the appendix and of Figs. 2 and 3, based on that formula, will disclose that full compensation is not justified, but that some sacrifice in boiler efficiency should be accepted. The best feed-water temperature will be a compromise between a high temperature advantageous to the turbine, and a low temperature advantageous to the boiler.

Economic considerations also indicate that when the steam-generating system consists of a boiler plus an air preheater, an increase in steam pressure is accompanied by an elevation of the most economical final-gas temperature, and therefore by a lowered efficiency of steam generation. This is due to the fact that increasing the steam pressure also raises the temperature of the gases out of the boiler, and this effect cannot justifiably be fully compensated for by an addition of air-preheating surface. With the inclusion of an economizer in the system, an increase in the outlet temperature of the boiler gases is largely self-compensatory, the reason being that the mean temperature difference in an economizer is increased by an increase in the inlet-gas temperature, whereas in an air heater it is reduced.

The writer wishes to acknowledge his indebtedness to J. H. Redfield of Day & Zimmermann, Inc., K. M. Irwin of the United Gas Improvement Company, and J. E. Black of Babcock & Wilcox Company. These men read this article in manuscript and made valuable suggestions. Mr. Redfield also verified the formulas and some of the calculations. The writer wishes also to thank those men who contributed the data compiled in the table.

Appendix With Equations

Case I

To determine the most economical temperature of outgoing gases from an economizer or an air heater, when the inlet gas temperature and the inlet air or water temperature are fixed.

$$\frac{C_e}{KC_f} = \frac{(T_o - t_i)\ (T_i - t_o)}{(Ti - ti)} \qquad (1)$$

$$T_o^2 + \frac{T_o}{a}\left[(1-a)\,T_i - t_i\,(1+a)\right] - \left\{\frac{C_e}{aKC_f}\,(T_i - t_i) + \frac{t_i}{a}\left[(1-a)\,T_i - t_i\right]\right\} = 0 \qquad (1A)$$

C_e = Annual charges per sq.ft. of increment economizer or air heater surface.
K = Heat transfer rate through economizer or air heater in B.t.u. per hour per sq.ft. per deg. M.T.D.
C_f = Annual money saving per B.t.u. of heat recovered per hour. This is cost of fuel per B.t.u. multiplied into hours of service, divided by combined efficiency of boiler and air heater or economizer.
T_o = Outlet-gas temperature.
T_i = Inlet temperature of gas to economizer or air heater.
t_o = Outlet temperature of air or water.
t_i = Inlet temperature of air or water.
$a = (t_o - t_i) / (T_i - T_o)$.

Case II

To determine the most economical boiler-outlet-gas temperature in the case of a boiler plus an air heater, or a boiler plus an economizer, when the temperature of gases out of the air heater or economizer and the entering air or water temperature are fixed.

$$\frac{C_eK_b}{K_eC_b} = \frac{T_i - t_o}{T_i - t_s} \qquad (2)$$

Notation is same as for Case I, subscript e refers to economizer or air heater, subscript b to boiler. t_s is temperature of saturated steam.

$$T_i = \left(aT_o - t_i + \frac{C_eK_b}{K_eC_b}\,t_s\right) \div \left(\frac{C_eK_b}{K_eC_b} - 1 + a\right) \qquad (2A)$$

Case III

In a combination of boiler, air heater and economizer, to determine the proper temperatures out of boiler and economizer when the final flue-gas temperature and the entering air and water temperatures are fixed.

$$\frac{C_bK_e}{C_eK_b} = \frac{T_{ie} - t_s}{T_{ie} - t_{ow}} \qquad (3)$$

$$\frac{K_eC_a}{C_eK_a} = \frac{(T_{ie} - t_{iw})\ \ (T_{ia} - t_{oa})}{(T_{ie} - t_{ow})\ \ (T_{ia} - t_{iw})} \qquad (4)$$

Notation same as for Case II, subscript a refers to air heater and air, subscript w to water, subscript e to economizer

$$a_eT_{oe}^2\left(\frac{C_aK_b}{K_aC_b} - (1 - a_a)\right) + T_{oe}\left\{\frac{C_aK_b}{K_aC_b}\right.$$
$$[(1-a_e)\,t_s - (1+a_e)\,t_{iw}] - (1-a_a)\left[\frac{C_eK_b}{K_eC_b}\,t_s - \left(\frac{C_eK_b}{K_eC_b} + a_e\right)t_{iw}\right] - a_e\,(a_aT_{oa} - t_{ia})\Big\} - \Big\{t_{iw}\,\frac{C_aK_b}{K_aC_b}$$
$$\left[(1-a_e)\,t_s - t_{iw}\right] + (a_aT_{oa} - t_{ia})\left[\frac{C_eK_b}{K_eC_b}\,t_s - t_{iw}\left(a_e + \frac{C_eK_b}{K_eC_b}\right)\right]\Big\} = 0 \qquad (4A)$$

Formula 5 and Its Application

The preceding formulas can be solved using the relationship:

$$a\,(T_i - T_o) = (t_o - t_i) \qquad (5)$$

$$a = \frac{EC_gW_g}{C_wW_w} \quad \text{or} \quad \frac{EC_gW_g}{C_aW_a}$$

In these:

C = Specific heat of gas, air or water, as indicated by subscript.
W = Mass flow of gas, water or air, lb. per hr.
E = Efficiency of economizer or air heater.

APPLICATION OF FORMULAS

Case I—Determine most economical final gas temperature assuming following data:

C_e = \$0.13
K = 2.38 B.t.u. per hr. per sq.ft. per deg. M.T.D.
Cost of coal = \$2.35 per 2,000 lb.
Heat value of coal = 12,660 B.t.u. per lb.
Combined boiler, air heater and economizer efficiency = 88 per cent.
Hours of service per year = 5400

$$C_f = \frac{5400 \times 2.35}{0.88 \times 2000 \times 12{,}660} = 0.00057$$

T_i = 610 deg.
t_i = 70 deg.
a = 1.593

From Formula 1, $\dfrac{(T_o - t_i)\,(T_i - t_o)}{(T_i - t_i)} = \dfrac{C_e}{KC_f} = 96$

From Formula 5, $T_i - T_o = \dfrac{t_o - t_i}{a} = \dfrac{t_o - t_i}{1.593}$

The following solutions are found to satisfy the foregoing two equations.

t_o = 440 deg.
T_o = 378 deg.

Case II—To determine proper temperature of gases out of boilers, assuming following data:

T_o = 750 deg.
t_s = 600 deg.
t_i = 300 deg.

$$\frac{C_eK_b}{K_eC_b} = 1.25$$

$a = \frac{1}{3}$

From Formula 2, $\dfrac{T_i - t_o}{T_i - t_s} = \dfrac{C_eK_b}{K_eC_b} = 1.25$

From Formula 5, $T_i - T_o = \dfrac{t_o - t_i}{a} = 3t_o - 3t_i$

Substituting in the above formulas and combining, we have $7t_o$ = 3150 deg.
t_o = 450 deg.
T_i = 1200 deg.

Case III—To determine proper inlet-gas temperatures to economizer and air heater, assuming following data:

t_{ia} = 80 deg.
T_{oa} = 350 deg.
t_{iw} = 300 deg.
t_s = 600 deg.

$$\frac{t_{ow} - t_{iw}}{T_{ie} - T_{ia}} = a_e = \tfrac{1}{3}$$

$$\frac{t_{oa} - t_{ia}}{T_{ia} - T_{oa}} = a_a = 1.3$$

$$\frac{K_eC_a}{C_eK_a} = 0.40$$

$$\frac{C_bK_e}{C_eK_b} = 0.80$$

From Formula 3 we have

$$\frac{T_{ie} - t_s}{T_{ie} - t_{ow}} = 0.80 \qquad \textbf{(a)}$$

From Formula 4

$$\frac{(T_{ie} - t_{iw})}{(T_{ie} - t_{ow})}\,\frac{(T_{ia} - t_{oa})}{(T_{ia} - t_{iw})} = 0.40 \qquad \textbf{(b)}$$

Assume for first approximation that

$$\left(\frac{T_{ie} - t_{iw}}{T_{ie} - t_{ow}}\right) = 1$$

then

$$T_{ia} - t_{oa} = 0.40\,T_{ia} - 0.40\,t_{iw}$$
$$0.6\,T_{ia} = t_{oa} - 120 \qquad \textbf{(c)}$$

From Formula 5

$$t_{oa} - t_{ia} = 1.3\,(T_{ia} - T_{oa})$$

from which

$$t_{oa} + 375 = 1.3\,T_{ia} \qquad \textbf{(d)}$$

Combining (c) and (d) and solving for T_{ia}, we have T_{ia} = 710 deg.
Substituting known values in (a) above, we have

$$T_{ie} = 3000 - 4.00\,t_{ow} \qquad \textbf{(e)}$$

Also, from Formulas 5,

$$3\,(t_{ow} - t_{iw}) = (T_{ie} - T_{ia})$$

From which, substituting for t_{iw} and T_{ia}, we have

$$T_{ie} = 3\,t_{ow} - 190 \qquad \textbf{(f)}$$

combining (e) and (f) and solving for t_{ow}, we have

t_{ow} = 456 deg.
T_{ie} = 1176 deg.

These are first approximations:
substituting values for T_{ie}, t_{iw} and t_{ow} in (b) we have

$$1.20 \times \frac{T_{ia} - t_{oa}}{T_{ia} - t_{iw}} = 0.40$$

$$\frac{T_{ia} - t_{oa}}{T_{ia} - t_{iw}} = 0.333 \qquad \textbf{(g)}$$

and in place of (c) we have

$$0.667\,T_{ia} = t_{oa} - 100 \qquad \textbf{(h)}$$

This gives as final solutions

T_{ia} = 750 deg.
T_{ie} = 1,200 deg.
t_{ow} = 450 deg.

American Crude Oil Production Rose 12 Per Cent in 1929

ACCORDING to preliminary figures compiled by the Bureau of Mines, Department of Commerce, from companies that operate gathering lines, 1,005,598 bbl. of crude petroleum was transported from producing properties in the United States during 1929. The final figure of actual production (oil brought to the surface), which will include revisions to the monthly data, crude oil consumed on the leases, and the net change in producers' stocks may amount to 1,006,000,000 bbl. This is 12 per cent above the 1928 output.

According to preliminary data, the world's production of crude petroleum in 1929 amounted to 1,488,604,000 bbl., an increase over 1928 of 12 per cent. Of this total the United States produced 67.6 per cent.

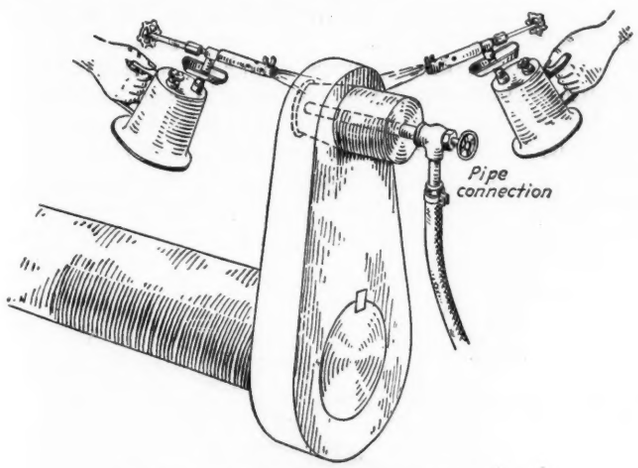
The statistics of both kerosene and lubricants in 1929 were practically unchanged from 1928. The American production of gas oil and fuel oil increased, due to the greater demand throughout.

...RIGHT OUT OF THE PLANT...

Removing Engine Crankpin

A method we used recently to remove a crankpin where the facilities for doing such work were somewhat limited is shown in the accompanying illustration. The pin was in such a condition that it was impossible to run without a stream of water pouring continuously on the crank.

As the engine was in a light plant, the longest it could be out of commission was twelve hours. A new pin was ordered from the manufacturers, and upon its arrival the work was started. The beading was cut off the back, a



Web was heated with torches while the pin was water cooled

hole drilled through the length of the old pin for a ½-in. pipe and connected to the water supply. The web was heated on both sides with blow torches, and two solid blows loosed the pin in the taper.

The new pin was inserted at once while the web was hot, and as soon as the web had cooled down it was beaded over. The complete job required only about eight hours, and the engine ran without any further trouble from the crankpin. GEORGE JACOBS

Flint, Michigan.

Boiler Drums Crack From Mechanical Causes

IN THE study and investigation of the cracking of plates in steam boilers there has been a tendency to indulge in much theory to the neglect of clear evidence of destructive residual stresses in the joints as constructed. It is not pleasant to realize that, where plate ends for riveted-joint construction are badly formed, the external surface of the plate is badly stressed, often to the yield point, without internal pressure. It is of the utmost importance that shell or drum plates be truly and correctly formed, so that the plate will be uniformly loaded. If a shell were truly cylindrical and seamless, there would be some eccentricity of loading, somewhat comparable to the welding of strips to one side of a tension test specimen for use in a testing machine. This condition will increase with plate thickness. Any flexing in the region of the riveted joints will cause serious local stresses.

A study of conditions found in two cracked joints in the mud drums of a double-ended boiler in a large industrial plant in Detroit will be of interest. With an instrument of my own design called a "radiiscope" I made careful measurements of the ends of the drum plates of the two mud drums of one of the boilers. The straps had been removed to determine the residual stresses set up along the center line of the rivets by the failure to form the plate ends to the correct curvature or radius. Cracks were found on the west side of the west drum and on the west side of the east drum.

The nominal inside diameter of these drums is 60 in. With a plate $1\frac{5}{16}$ in. thick the external radius should be $31\frac{5}{16}$ in. for any part of either drum. In forming these drums from $1\frac{5}{16}$-in. plate, the external surface of the plate elongates about 4.123 in. and the internal surface shortens about the same amount. Ordinarily the neutral axis, or center, of the plate remains unchanged in length. With a drum of 60-in. diameter the outer surface will be elongated about 2.1 per cent. A smaller drum with the same plate thickness will be elongated the same amount, but the percentage will be greater. The same applies to the inner surface of the plate where the change has been a shortening or "upsetting."

It will be seen that a serious disturbance of the grain structure of the plate has taken place on both sides of the neutral axis; on the outer surface a stretching and on the inner surface a shortening. The metal at the plate center is practically unchanged. The disturbance starts near the plate center and increases to its maximum at the external surfaces.

The accompanying tabulation of radii found on drum plates above and under the straps shows clearly why cracks occurred along the longitudinal joints. Measure-

TABULATION OF RADII OF BOILER MUD DRUMS
(Normal Radius, $31\frac{5}{16}$ In.)

	1	2	3	4	5	6	7	8
	West Side of West Drum							
A.....	29.02	32.30	30.80	36.66	33.08	31.73	35.84	30.10
B.....	56.32	45.48	45.48	44.46	43.50	39.24	40.25	33.37
C.....	57.16	58.83	58.83	43.62	43.50	55.57	56.24	58.83
	West Side of East Drum							
A.....	29.88	39.22	29.43	32.55	54.30	31.52	28.50	30.80
B.....	54.07	68.96	43.62	64.53	59.70	33.08	56.24	50.00
C.....	45.44	65.68	43.62	58.83	51.27	53.35	53.38	64.53
	East Side of East Drum							
A.....	30.80	30.80	41.68	29.22	27.43	35.84	35.84	34.50
B.....	58.83	45.44	41.68	48.50	52.65	52.65	48.85	46.80
C.....	39.38	64.53	61.50	41.66	48.85	57.97	51.27	52.75

ments in row *A* were taken in each case above the location of the outer strap. Row *B* measurements were taken on the surface under the top half of the strap. Measurements in row *C* were taken on the surface under the bottom half of the strap. The numerals indicate the order of the readings from the north end of the drums. No. 1 was taken inside the girth riveting of the north heads, and No. 8 was similarily taken from the south heads. The six readings between the heads were evenly spaced.

In a few instances the radii of the plate ends were slightly below the nominal of $31\frac{5}{16}$ in., but in many cases the radii were excessive and of necessity introduced serious stresses along the line of rivet centers when the riveting was completed. Where the radius is below the nominal, the stresses are on the inside surface of the plate, and when excessive, the stresses are on the outer surface of the plate. In several cases the stresses set up in the outer fiber exceeded 10,000 lb. from flexure.

In a boiler drum made from $1\frac{5}{16}$-in. plate, as in this case, and with an external radius of $31\frac{5}{16}$ in., when a curvature incidental to nearly twice that is frequently found, and in cases more than twice, it must be evident that serious stresses will be set up in the outer fiber of the metal. The change of outer surface length due to forcing the plate ends more to the nominal radius will localize the stresses and elongations along the line of rivet centers. This immediately throws the outer fiber into tension, and the inner surface, directly opposite, into compression.

In a section of plate $1\frac{5}{16}$ in. thick and 1 in. long in direct tension it will require a load of about 39,375 lb. to stress it to the yield point. In the case of a plate under flexure of the same dimensions as the foregoing, the moment of resistance will be 0.287, and it will require a load of only 8,610 lb. to load the extreme fiber to the yield point. (A yield value of 30,000 lb. is assumed in both cases.)

In a joint already placed in flexure, as is the case in the joints in question, with an extreme fiber load of 10,000 lb. or more, it will be evident that when the internal load due to pressure is applied, the added load will be taken up first by the already well-loaded outer fiber of the metal. No load can be taken up by that portion of the plate inside the neutral axis until the outer fiber is badly overloaded.

The assumption that failure between ferrite crystals is evidence of "caustic embrittlement" is misleading. Consideration first must be given the manner of plate loading and the workmanship on the ruptured joint.

A study of the tabulated radii will show that cracking of the longitudinal joints was due to defective forming of the plates. An examination of the metallurgical report on the metal in the south head indicated that it was flanged at a temperature too far below the upper critical.

J. C. McCabe,
Detroit, Mich. *Chief Boiler Inspector of Michigan.*

I Wish to Call Attention to a slight error in the Jan. 21 number of *Power*. On page 103 there is a short report of Mr. Dow's talk to the A.I.E.E. in which it states that Marysville power plant operated at 19,290 B.t.u. per kilowatt-hour. This is an obvious error; Connors Creek power plant operated at 19,290 B.t.u., while Marysville operated at 15,430 B.t.u. per kilowatt-hour.

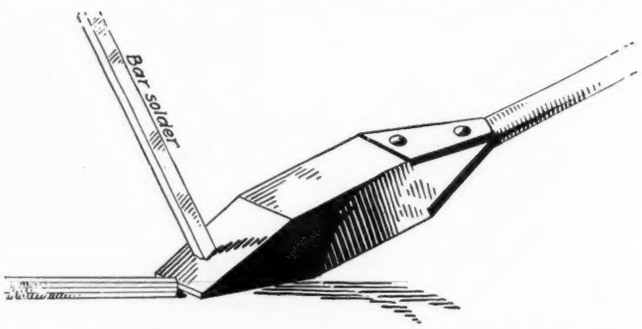
Harry A. Snow,
Detroit, Mich. The Detroit Edison Co.

Pointers on Soldering Electrical Apparatus

I READ with interest the short article entitled "Pointers on Soldering Electrical Apparatus" in the Jan. 14 number of *Power*, because I have had an extensive experience soldering electrical apparatus in power plants.

While, as stated, it is undoubtedly good practice to tin the upper side and the end only of the soldering iron, in order to prevent the customary waste of solder (when the four sides are all tinned) when holding the soldering tool in a horizontal position, there are, however, more essential points to be observed. The soldering iron shown in the accompanying sketch, for example, with its wedge-shaped end, is a much more efficient tool for getting the necessary heat to the work and conveying the solder than one with a pointed tip as shown in the article referred to. When an iron with a pyramid end is used, the sides are of such an acute angle that it cannot satisfactorily convey sufficient heat to the areas to be soldered; whereas a wide or wedge-shaped soldering iron will not only fuse the solder speedily, but also will heat and tin electrical apparatus satisfactorily. There are various sizes of wedge-shaped soldering irons employed on electrical apparatus, varying from $\frac{1}{2}$ in. to 3 in. wide and from $\frac{1}{16}$ in. to $\frac{1}{4}$ in. thick at the end.

It should be emphasized that when soldering certain electrical apparatus, or upright seams on sheet metal products, or vertical pipe jobs in power plants, it is



Wedge-saped soldering iron for certain classes of work

desirable that the soldering iron should be forged wedge-shape and tinned on the end and top side only. If the iron is tinned on the four sides much of the solder will run to the under side and away from the work and result in a waste of time and solder. When the sides are untinned they do not carry the solder downward, but onto the seam or joint where it is needed.

When soldering many kinds of electrical apparatus, or for general bench work, pointed irons can in some cases be advantageously used, with the four sides tinned for a distance of about $\frac{3}{4}$ in. from the point. The solder is generally applied to the tinned area on the iron and flows therefrom onto the areas or surfaces to be soldered.

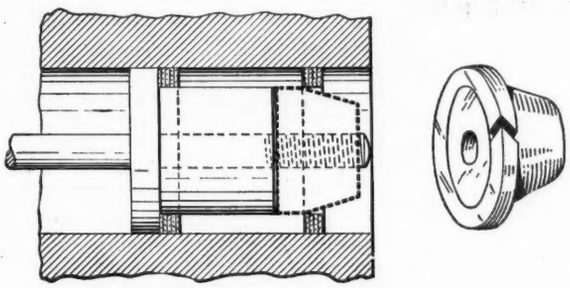
Experience proves that, whatever type of soldering iron selected, it must have capacity adequate for the work upon which it is to be used. This is important, yet it is a point often overlooked, even by mechanics. Much better results can be obtained by using a comparatively heavy soldering iron on light work than a light tool on heavy work. Only when the metal surfaces to be joined have absorbed the necessary heat to melt the solder freely, can a properly soldered electrical connection or joint be secured.

E. Andrews.
Manchester, Eng.

Cone-Shaped Collar Facilitates Packing of Water Piston

ON SOME classes of water pumps repacking of the water piston is rather a disagreeable task owing to the difficulty in getting the proper size of packing onto the piston without tearing or jamming it against the edge of the piston.

To overcome this trouble we made up a cone-shaped collar to fit on the end of the rod against the piston after



Collar in position for packing piston

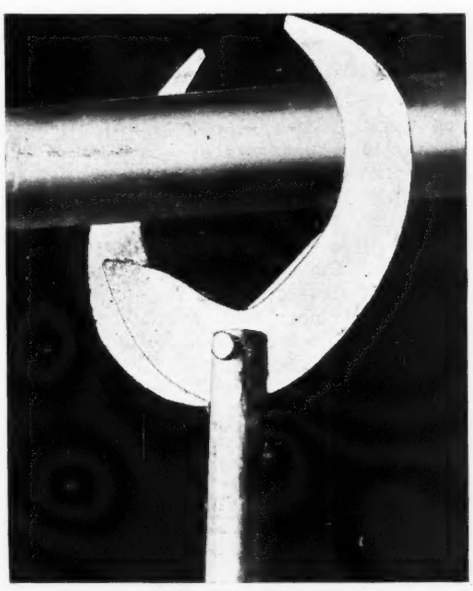
the follower plate had been removed. The collar, as indicated by the heavy dotted line and separate detail in the accompanying illustration, is made with a short parallel section the same diameter as the piston. This section not only serves to guide the packing into position on the piston, but also permits the rings to be fitted and cut to the proper length before the pump is taken out of service.

W. A. COOIL.

Ladysmith, B. C., Canada.

Special Calipers for Measuring Overhead Pipes

RECENTLY I came across a practical device for use when checking up the sizes of piping placed where it is necessary to use a ladder to reach them in the ordinary way. The device is essentially a pair of firm-joint calipers pivoted to a long rod, but made so that they can be adjusted without the usual tapping so necessary when setting ordinary calipers. They are made of sheet metal, and each leg is extended beyond the joint to the shape shown, so that when the calipers are opened these extensions form a Vee.



Calipers are both opened and closed by pressing against the pipe

To measure the size of an overhead line of piping the calipers are opened by hand, then raised by the handle and adjusted to fit the pipe by simple upward pressure. To open, the points are pressed against the pipe. To close, the Vee formed by the leg extensions is pressed against the pipe.

H. MOORE.

Hamilton, Ont., Canada.

Why the Engine Cylinder "Missed"

I HAD AN experience some time ago that may prove useful to engineers operating four-stroke-cycle Diesel engines.

A 120-hp. air-injection four-stroke-cycle Diesel on the town's water-supply pumps began to "miss." Inspection disclosed nothing about the exterior of the engine that indicated the trouble, so the switch was pulled on the water-pump circuit. The engine immediately began to "hit" on all four cylinders again.

After the engine had cooled down we put the pumps back on, but after about 30 minutes' running No. 3 cylinder began to miss again and the engine began to heat up. The exhaust was black, showing that the cylinder was getting fuel.

It was decided to look into No. 3 cylinder. The exhaust valve was taken out, but revealed nothing unusual. On close examination, however, one could see that the valve had been leaking. The clearance had been checked thoroughly, so we knew that was not the trouble.

Looking closer we were able to see that the neck of the valve was riding on the guide of the valve cage and that this had held the valve open when the engine got enough load on it to expand the valve neck. When some of the load was dropped the engine would cool down and the neck would contract enough for the valve to close, so the engine would then fire on all cylinders.

The valve had come with the engine, and the refacing necessary to correct its seat had let it come against the guide. We put the valve in a lathe and cut back the neck about $\frac{1}{4}$ in. and since then we have had no trouble.

Kimball, S. D. ART WILLIAMS.

Royal York Hotel Does Most of Its Cooking by Gas

IN THE Jan. 14 number of *Power* there appeared an article on the Royal York Hotel, Toronto, Ont. In the second paragraph on page 54 there is the following statement: "Cooking throughout the hotel is done electrically. Alternating current for this purpose is supplied by three 125-kva. single-phase transformers and fed through three-pole double-throw switches. . . ."

As this is so far from being the case, a correction of the statement would seem to be in order. Although a small amount of cooking is done by electricity at the Royal York, the major portion is done by gas.

G. W. ALLEN, *Secretary and Treasurer,*
Toronto, Ontario. Canadian Gas Association.

From Among Readers' Problems

Conducted by
L. H. MORRISON

FINDING THE EFFICIENCY OF A JOINT —*What is the efficiency of a double-riveted lap joint if the metal is 0.31 in. thick, 65,000 lb. tensile strength, and the rivets ¾ in. diameter pitched 2.5 inches?* E. R. P.

A boiler seam may fail in three ways: (1) rupture of the sheet between the rivet holes; (2) crushing of the plate in front of the rivet, that is between the rivet and the edge of the plate; and (3) by shearing the rivet.

You must examine each and discover the weakest, to determine the joint efficiency.

If the plate is 0.31 in. thick, tensile strength 65,000, pitch 2½ in. and rivets ¾ in. diameter, then the strength of the solid plate in a unit section between rivet centers is $65{,}000 \times 2\frac{1}{2} \times 0.31 = 50{,}375$ lb. Strength of the plate between rivets is obviously $65{,}000 \times 0.31 \times (2\frac{1}{2} - \frac{3}{4}) = 35{,}262$. You do not give the crushing strength of the plate, which I will assume to be 100,000 pounds.

The metal to be crushed is the width of the rivets in a unit length × the thickness of the metal × crushing strength. (Note that due to the two rows of rivets, there are two rivets to be crushed.) So the crushing strength is $2 \times 100{,}000 \times \frac{3}{4} \times 0.31 = 46{,}500$.

To compute the shearing strength of the rivets, multiply the area of one rivet by the number of rivets in the unit section and by the shearing strength of the rivet. The latter I will assume is 50,000. There are two rivets in shear in the unit section, so the shearing strength $= 50{,}000 \times .7854 \times (\frac{3}{4})^2 \times 2 = 44{,}178$ lb.

Inspection shows that the joint would fail by rupture of the metal between the rivet holes, as this has a strength of but 35,262 lb. So the joint efficiency is

$$\frac{35{,}262}{50{,}375} = 70 \text{ per cent.}$$

If, however, crushing strength of the sheet and shearing strength of the rivets be lower than I have assumed, the joint might fail by shearing or crushing.

EFFICIENCY OF DIESEL ENGINE—*Can the formula for the air cycle be used to find the probable efficiency of a Diesel engine?* H. C. F.

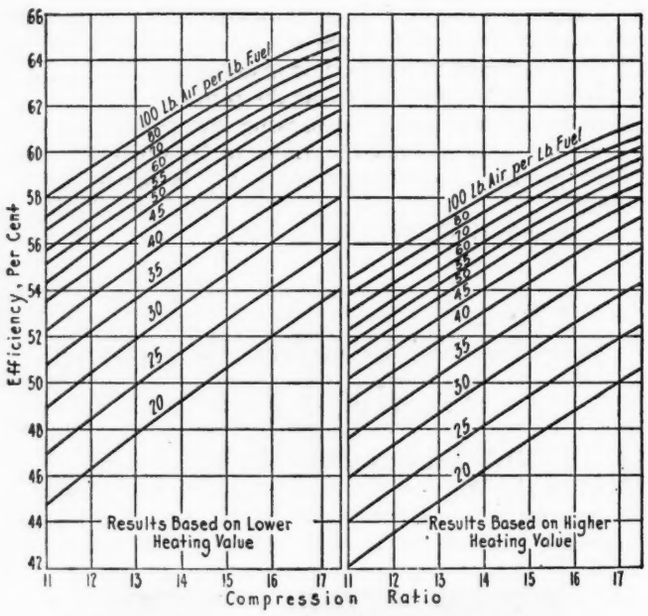
The air-cycle efficiency formula is

$$E = 1 - \left(\frac{1}{r}\right)^{\gamma - 1} \times \frac{\rho^{\gamma} - 1}{\gamma(\rho - 1)},$$

in which γ = ratio of specific heats,
r = ratio of compression, and
ρ = ratio of cut-off volume to clearance volume.

This should not be used to check the efficiency of an actual engine, for the reason that the air-cycle efficiency for any given compression ratio and cut-off ratio is too high, as no account is taken of the variation in the specific heat.

Prof. F. O. Ellenwood, Cornell University, has worked up a set of charts showing the actual ideal efficiency for both the Otto and Diesel cycles. In the illlustration are shown sets of curves based on Ellenwood's calculation using both the lower and higher heat values of the fuel. It will be noticed that the efficiency increases with the air-to-fuel ratio, but in the actual engine the net horsepower output per pound of air will decrease with an increase in the ratio, although the thermal efficiency will increase. This is due to the mechanical losses.


Efficiency, Per Cent
Compression Ratio
100 Lb Air per Lb Fuel
Results Based on Lower Heating Value
Results Based on Higher Heating Value

Theoretical variation of Diesel efficiency with different air-to-oil rates, based on a variable specific heat

CORRECTING POWER FACTOR WITH SYNCHRONOUS MOTORS—*We have three 200-hp. unity-power-factor synchronous motors directly connected to pulp refiners, which are not operated continuously. Would it pay, when the refiners are shut down for some time, to disconnect the motors from their load and operate them as synchronous condensers?* F. S.

As a general proposition it will not pay to operate the motors as synchronous condensers to correct the power factor above 0.82. This power factor is fairly good, and to increase it will require considerable corrective capacity even for a small improvement. For example, if it were possible to operate one of the 200-hp. motors at its full rating as a synchronous condenser at zero leading power factor, it would correct the power factor of the system to only about 0.86.

The benefit gained from operating the motors as synchronous condensers will depend upon where they are on the system. For example, in the figure, if the synchronous motors are supplied over an independent feeder such as *C*, the power factor of the system will be corrected in the power house only. Under such a condition, the losses in the feeder and the motors will increase

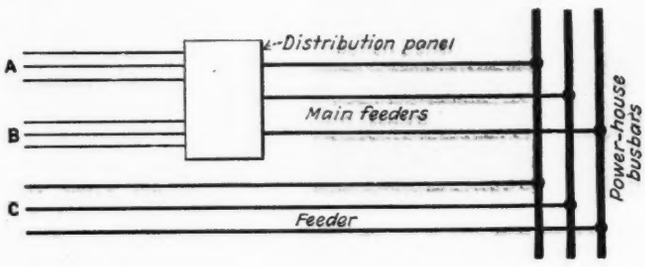


Diagram of power distribution system

the generator's kilowatt load to a value where the kilovolt-ampere load on the plant will be reduced very little if any. If the synchronous motors are supplied from the same distribution panel as the induction motor load, such as feeders *A* and *B*, the power factor of the main feeders from the panel back to the power house will be corrected. The reduction in losses in these feeders, due to improving the power factor, will tend to offset the losses in the synchronous condensers and make it more favorable to correct the power factor. In this case, however, the gain is so small as to make it very doubtful whether operating the motors as synchronous condensers can be justified.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

WHAT is the best furnace arrangement for burning hogged fuel in conjunction with pulverized coal—pyramid grates, flat grates, refractory hearth or water-tube furnace floor? G. R. V.

IT IS assumed that "hogged fuel" is waste from saw mills, comprising sawdust, shavings, plank ends, etc.

In my opinion, the stepped grate is the most economical type for burning this fuel. It gives higher combustion rates than the flat type; it is self-feeding; and a larger grate area can be obtained in a given floor space.

When the same furnace is to burn pulverized coal, and assuming a vertical-tube boiler, a suitable arrangement is to fit the pulverized fuel burner in the bridge wall, as shown in the sketch.

It is usual to run the base load on hogged fuel, and carry heavy fluctuating and peak loads on the pulverized fuel. This insures that the step grate will be covered when using the pulverized fuel.

Mechanical agitation should be adopted on the stepped grates, to make them self-cleaning, leading to a more uniform air flow through the fuel bed and allowing boiler ratings much higher than those obtainable with hand-agitated grates.

It must be appreciated that site and operating conditions will to a large extent govern the design of furnace.

T. H. PARDOE

Wolverhampton, England.

THE BEST furnace arrangement for burning hogged fuel in connection with pulverized coal, provided the hogged fuel is comparatively dry, is to introduce it through chutes near the top of the furnace, allowing the fuel to fall toward a flat refractory furnace bottom, and introduce air through side-wall ports located about one foot above the furnace bottom. The ports should be of such size and the air of such pressure that jet velocities will be sufficient to agitate the wood which might fall onto the furnace bottom. All the air for combustion of refuse would be passed through the side-wall ports.

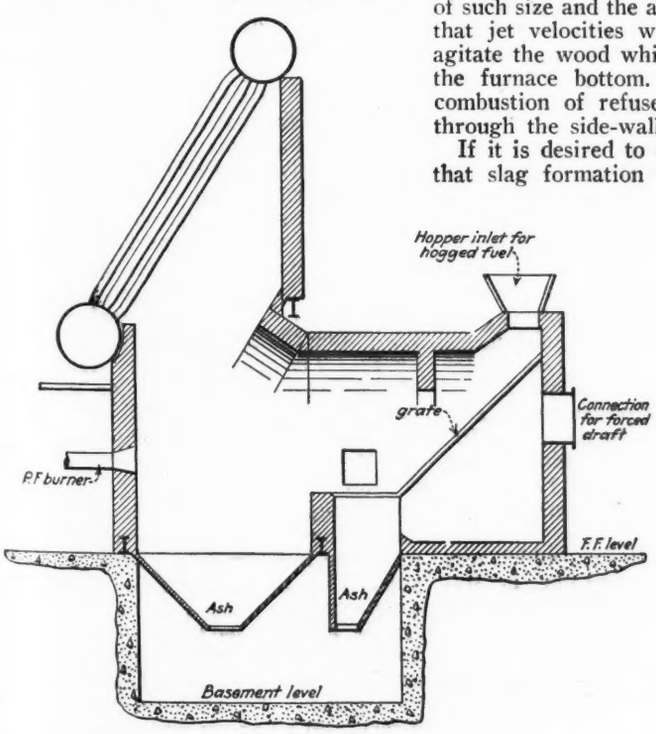
If it is desired to carry ratings such that slag formation would occur with refractory walls, water-cooled surface can be added to the side walls. It is more desirable to add it to the side walls than to the bottom, since if pulverized coal were fired the coal ash would cover the water-cooled bottom and form an insulation. Pyramid or flat type grates are not satisfactory for this arrangement, since they are subjected to radiant heat from the pulverized coal flame.

This type of furnace would not be suitable for burning wet hogged fuel, but it is doubtful if any type of furnace could be devised which would satisfactorily burn both wet hogged fuel and pulverized coal.

A recent issue of *Power* described an installation designed as indicated above in which the side walls were almost entirely covered with water-cooled surface and in which hogged fuel was burned in sufficient quantity to develop 300 per cent of rating on the boilers without smoke. O. CRAIG

Riley Stoker Corporation

Worcester, Mass.



The suggested method of arranging the furnace to burn pulverized coal and hogged fuel

A NEW design of refractory step grate having vertical tuyeres and horizontal slots with proper dampers for the admission of a regulated quantity of preheated air and used in conjunction with either a refractory hearth or water-cooled floor has proved most satisfactory.

The proper type and relation of fuel feeders or burners, together with good general furnace design, are essential in any case.

With such an arrangement the ideal condition of burning in suspension is most nearly met, the heavier particles of wood that drop on the grate are supplied with the necessary air for complete combustion, which prevents piling up on the grate and the attendant slagging.

One installation of step grates and water walls on several old boilers increased the output 60 per cent over that previously obtainable. F. W. WELSH

Thos. E. Murray, Inc.

New York City.

A Question for Our Readers

THE heating system for our ten-story building was recently reconditioned. Orifices were installed in the radiator inlets and a pressure-regulating valve was placed in the main from the boilers. Under these conditions are thermostatic traps still necessary at the radiator outlets? R. A. R.

Suitable answers from readers will be paid for and published in the April 1 number.

Water Conditioning for High Pressures

The New York Steam System

For more than a year the plants of the New York Steam Company have been practically free from scale and corrosion troubles in spite of evaporation rates that reach 400,000 lb. per hour per boiler. Metered control of chemical feed direct to the boilers is credited with this result. The method is outlined in this abstract of a paper presented before the Metropolitan section of the A.S.M.E. on Feb. 3.

By A. A. MARKSON
Mechanical Engineer
New York Steam Corporation

THE PURPOSE of any system of boiler water treatment is to maintain such conditions in the boiler water that the production of steam will not cause the formation of deposits on the heating surfaces. If, in the accomplishment of the primary object, secondary difficulties develop, these latter must be eliminated without interfering with the accomplishment of the main objective.

At Kips Bay station of the New York Steam corporation the Hall system of boiler water conditioning by means of phosphate was found to be extremely satisfactory in the elimination of deposit from the heating surfaces, but in its original application secondary difficulties either existed or arose which had to be traced down and eliminated.

These difficulties were as follows:

1. The boilers produced wet steam.
2. Heavy deposits formed in the economizers.
3. It was not possible to maintain low alkalinities in the boiler water while maintaining economizer corrosion protection.

The problem of wet steam at Kips Bay, and its solution, has been fully discussed in a paper by A. R. Mumford, "Boilers and Furnaces," published in Vol. 51, No. 22, of the *A.S.M.E. Transactions*. Study of this problem developed the following facts: (*a*) That there was a critical value of the concentration of boiler caustic alkalinity above which it was practically impossible to accomplish the mechanical removal of entrained moisture, and below which mechanical purification was entirely practicable; (*b*) that the concentration of other dissolved substances and suspended matters had a negligible influence on the quality of steam delivered from the boilers, within the concentration ranges covered in the experiments.

Caustic concentration was kept below the critical value by increasing the blowdown until its control by chemical means could be effected. Sources of the caustic were two: That added to inhibit the economizer corrosion, and that formed by the breakdown of the carbonates in the boiler water. Some caustic alkalinity is necessary in boiler water to insure the maintenance of conditions called for by the Hall system for the formation of non-adherent precipitates. Obviously the economizers would be subjected to accelerated corrosion by the elimination of the caustic added to the feed water. Furthermore, presence of carbonates in the make-up insured a constantly increasing concentration of caustic soda in the boiler water.

Because no deposits formed in the economizers before the Hall system was adopted, it was obvious that the adding of conditioning chemical directly to the boiler would eliminate completely the zones unfavorable to conditioning by the Hall system. By using a less alkaline sodium phosphate than was previously employed advantage could also be taken of the possibilities of keeping the boiler alkalinity under control by partial neutralization in the boiler rather than by excessive blowdown.

The author has noted considerable interest on the subject of economizer and feed-line scale deposition, as evidenced by several recent articles on the subject, both of an experimental and a speculative nature.

In the writer's opinion, the cause of economizer and feed-line scale deposition is primarily the maintenance of lower alkalinity in the feed water than is required to prevent the formation of non-adherent precipitates. This required alkalinity is in excess of 100 parts per million of OH, fivefold higher than the maximum we could economically add because of the resultant high blowdown required.

In developing the system which was installed at Kips Bay, and later at Station A, certain mechanical conditions were set forth which must be met by the general scheme. In the first place, any such system ought to be simple to operate, to adjust, and to maintain. Second, the amount of special attendance necessary to its functioning ought to be a minimum. Third, the system ought to be under complete and accurate control at all times, with visible and positive indication of its functioning.

It is believed that the system which is to be described met these requirements very well. General simplicity of the design is evidenced by the fact that both the installed systems have shown no fundamental defects in ten months of operation at Kips Bay Station and five months at Station A.

The principle of the system may be briefly described: If a chemical charge of calculated strength be fed into the boilers in exact proportion to either the feed water entering the boilers or the steam generated by the boilers, the optimum condition for internal treatment of boiler water will be attained. The assumption that the amount of treatment is proportional to steam generated is probably true for most cases.

This is accomplished in the following manner: A high-pressure pump maintains a constant head of chemical solution in the distribution loop. Feeds to individual boilers are taken off this loop. A metering orifice is placed in each boiler chemical line and flow from the loop into the individual boiler is manually controlled by a needle valve placed after the metering orifice. The metering orifice indicates flow of chemical by means of a graduated manometer which is under the observation of the boiler operator. This manometer scale is graduated to correspond with the boiler-meter flow reading.

We used in our installation an 0.365 in. Monel orifice plate, carefully calibrated. For our orifices carbon tetrachloride (specific gravity 1.58) was selected as the manometer liquid. This was colored a brilliant red by the use of "pylol," a dye insoluble in water.

The control valve is placed at the manometer, so that the operator's duty is to maintain the manometer reading at the scale point corresponding to the reading of either his feed-water or steam meter in a manner analogous to controlling the air flow pen on the boiler meter. The control valve should be placed after the orifice, for obvious reasons. For the control valves we have found that quarter-inch Vogt steel needle valves function perfectly for our conditions.

In designing the loop a maximum velocity should be chosen which tends to make the loop act as a pressure reservoir. One or two feet per second is satisfactory. Welded joints are preferable, although we have had no trouble with screwed or flanged pipe on this service at our pressure (400 lb.). Check valves should be employed where necessary, and all valves and fittings ought

to be of iron or steel and of the best quality obtainable.

The pump, as might be expected, is the point in the system upon which success depends. The first one which was selected was a small triplex, and while its functioning was never such as to threaten the success of the system, we felt in selecting a changeover pump that the triplex could be considerably improved upon.

We have therefore installed a Waterous rotary pump. It works on a rotor-displacement principle and is directly driven by a slow-speed motor. The ideal pump is a centrifugal, but these are apparently not made in very high head and low enough capacities. If a pump of tremendous excess capacity is used it will be entirely too wasteful of power.

Triplex pumps, if enough care is taken in their selection, should be good for pressures up to about 600 lb. Rotary pumps, however, are good only for pressures up to 350 lb., but may be staged in series to give any desired working pressure. They are the cheapest and simplest for the service.

A spring-loaded relief valve is used to bypass the excess of fluid pumped back to the supply tanks and to maintain a fairly constant head on the discharge loop. The constancy of this head is very important, in order that the control needle valve will not require readjustment at constant rating. We were unable to buy a suitable all-iron valve for the service, but found that a standard bronze valve, when chromium plated, was satisfactory. If a pump is selected of ample excess capacity, a durable needle valve may be used instead of a loaded relief valve.

In the operation of the system the pump pressure should be set at a point that will insure a negligible effect of variations of boiler pressure on the flow through the boiler control needle valve. For example, if the boiler pressure varies five pounds from the usual operating point it will only affect the indication of the manometer slightly when a drop of 100 lb. is induced across the control valve, but rather seriously if the drop induced across the control valve is, say, in the neighborhood of only 10 lb.

A duplex suction strainer of our own making, having baskets of 40-mesh monel cloth, is arranged so that its strainer can be cleaned in about ten minutes without interrupting the service.

In conclusion, the advantages of a high-pressure system such as the one described are:

1. It solves the question of economizer deposition due to the nature of the conditioning chemical used. The writer has no available data on whether stage heaters show the same deposition, but it is obvious that the high-pressure system also solves this question.

2. While the primary object of the high-pressure system is to avoid deposition of scale in economizers and feed lines, it is apparent that it gives a flexibility of control which is far superior to adding the chemical directly to the feed-water heaters or hot wells.

3. The cost of installation of such a system is very moderate.

Some limitations that occur to the writer are:

1. It is not as adaptable to the needs of a very small plant, as it is to a very large plant.

2. It requires technical supervision of a better order than is required by the other method.

Figures show that a good estimate of the cost of installation of a complete system as described is about $8,000 or $250 per boiler. This figure includes two high-pressure pumps and supply tanks.

MR. MARKSON'S paper was followed by a discussion in which the principal participants were manufacturers' representatives. E. B. Ricketts of the New York Edison Company, as presiding officer, said that the old day of nostrums is passing and that problems of water treatment are now approached in a scientific spirit with the desire to determine causes and prescribe accordingly.

J. D. Yoder of the Cochrane Corporation agreed with Mr. Markson that the system described would be less applicable to the usual run of industrial plants. In New York the extremely low hardness of the city water make-up supply makes lime and soda treatment unnecessary, he said. Feeding one of the sodium phosphates to the boiler, with proper control of boiler water conditions, gives adequate treatment. The majority of industrial plants, he pointed out, have to use much harder make-up water. They would also find it a greater burden to keep a man constantly regulating the flow of chemicals to each boiler. Such plants, he stated are normally equipped with a lime-and-soda water softener, so that it is not difficult to arrange for proportionate feed of phosphates.

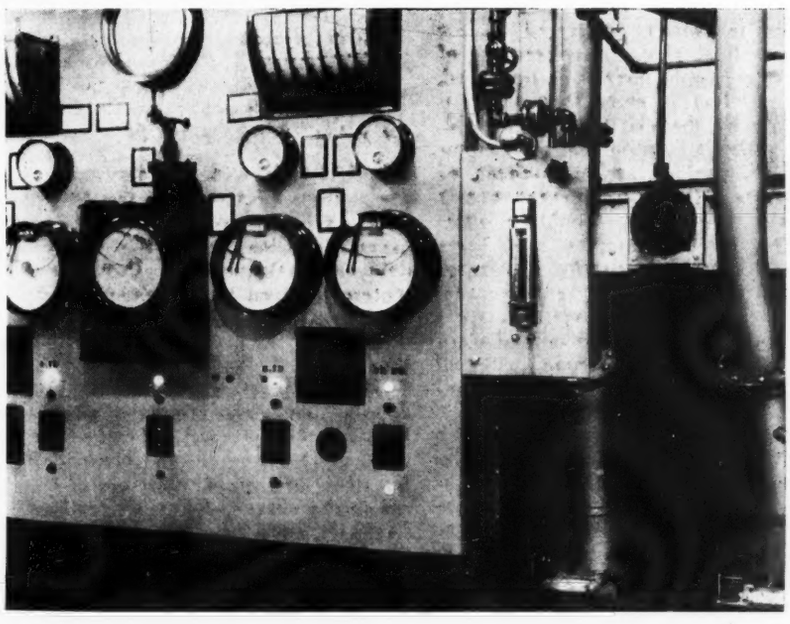
H. L. Tiger of the Permutit Company questioned the economic advisability of the system employed at the plants of the New York Steam Corporation. According to computations he made, a geolite treating system would save about $18,000 per year in chemicals (salt for zeolite regeneration as against sodium phosphate). He said that a zeolite system could be installed for $25,000 or $30,000, about $15,000 more than the cost of the high-pressure chemical feeding system actually used. In his closure, Mr. Markson took issue with the figures presented by Mr. Tiger. He felt that the cost of land would greatly raise the cost of the zeolite system. He also expressed a fear of caustic embrittlement and of deposits of silica in economizer and boiler.

The cost of idle boiler investment was emphasized by A. A. Mumford of the New York Steam Corporation. At Kips Bay, he said, the total investment (for four boilers) is over $1,000,000 per boiler. While it might seem that water treatment would be unnecessary with the extremely soft city-water make-up in New York, he said that one must not overlook the enormous evaporation rate of these boilers (running up to 500 per cent).

Without water treatment, it would be necessary to take each boiler off the line once every three weeks for a solid week of turbining at an overhead cost of $300 per day. With the system now employed, said Mr. Mumford, the boilers at Kips Bay have operated for one and one-half years, evaporating approximately 2,000,000,000 lb. of water each, without turbining. Without water treatment it would be necessary to invest in another boiler, costing an additional $1,000,000.

In conclusion, Mr. Markson announced that his company has already developed an automatic control that will take care of reasonable variations in make-up. This, he said, is not suitable for the extreme fluctuations found in industrial plants.

Manometer and control valve are shown on small board at right



THE ENGINEER'S

Unbiased Facts

THE CHANGING CHARACTER AND EXTENT OF MUNICIPAL OWNERSHIP IN THE ELECTRIC LIGHT AND POWER INDUSTRY. *By Herbert B. Dorau. Published by the Institute for Research in Land Economics & Public Utilities, 337 East Chicago Ave., Chicago, Ill. 102 pages; illustrated; 7½x10¼ in.; paper. Price, $1.50.*

HERE at last is an unbiased statistical study of the most controversial subject in the power industry—public ownership. Though only a preliminary part of a larger analysis and interpretation, nevertheless this report provides a substantial foundation for an open-minded consideration of the whole question. Those bewildered by the politics, propaganda and prejudice pervading this vital issue, will welcome it as a befogged mariner welcomes a clearing wind.

Concise, unimpassioned in treatment, Mr. Dorau's monograph sets forth the facts of municipal ownership of light and power systems. The changes in character and extent of such ownership are depicted from the earliest instances in 1882 to the comparatively recent status in 1927, by the aid of 97 carefully prepared tables and charts. These form the "meat" of the study, and incidentally, are brilliant examples of the best in modern statistical practice.

The report shows that from a meager four in 1882, municipal establishments in the country as a whole climbed steadily to a peak of 3,066 in 1923, dropping off to 2,320 in 1927. During those 46 years, 3,814 municipal systems were originated, 1,494 of which changed to and 827 of which started under private ownership. Breaking this down geographically, it is revealed that the northern portion of the Middle West has contributed the greatest number, with the Pacific Coast and New England vieing for last place.

Four groups of factors are listed as affecting the character of municipal ownership, as follows: legal and political factors, technical factors, economic factors and changes in the philosophy of the people at large with respect to the desirable extent of governmental conduct of essential services. While these are very briefly treated in the present report, the discerning reader can here and there pick out evidences of their effects from the data set forth. A more comprehensive consideration of these factors will be given, says Mr. Dorau, in the larger study and interpretation to be published as soon as the vast mass of information can be whipped into significant shape.

Among the interesting conclusions suggested by the study are those having to do with the stability and length of life of municipal establishments. Briefly, the distributing system, purchasing all of its electricity, finds a longer and more stable existence in small communities, while systems with complete generating facilities have a greater life in the larger population groups. Furthermore, taking all types of plants into consideration, "the size of the community in which municipal ownership developed certainly seems to affect the probability of its persistence. Beginning definitely as early as 1917 the smaller the community the greater became its relative disadvantages in trying to provide electric service on a self-sufficient and independent basis." Obviously, this was due to greater perfection of electric transmission.

Partisans on either side of the public ownership question will undoubtedly find justification for their respective beliefs in this admirable study. But both should be familiar with the factual information it presents before forming conclusive opinions.

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For Operating Engineers

HANDBOOK OF REFRIGERATING ENGINEERING. *By W. R. Woolrich, Professor of Mechanical Engineering, University of Tennessee. Cloth; 4½ x 7 in.; 318 pages; numerous tables and illustrations. Published by D. Van Nostrand Company, Inc., 250 Fourth Ave., New York City. Price, $4.*

AS THE author states in the preface, the book is intended for engineers who operate refrigerating plants. The material is written in a simple, clear style, and no attempt is made to delve into the scientific, or thermodynamic, side of refrigeration, for which the author is entitled to congratulations on his acumen. At present there are ample theoretical treatises, and the operating engineer is chiefly interested in the more practical side. Arrangement of the chapters could have been improved, but this defect is more than compensated for by the clarity of treatment.

The author's opinion that the volume meets the need of senior students of engineering colleges is, however, overly optimistic. A student should be interested in basic principles and these are barely treated. Briefly, Professor Woolrich covers cold storage, compression systems, absorption systems, various refrigerants, and the details of plant operation. The operating man will find the volume well worth the price and the time spent in reading it.

The method of illustrating the way in which theory can be applied to the working out of practical plant problems, consisting of the use of definite values in the formula, is to be commended.

The volume should find a place in the engineer's five-foot book shelf.

Welding Terms

WELDING AND CUTTING NOMENCLATURE, DEFINITIONS AND SYMBOLS. *Published by the American Welding Society, 33 West 39th St., New York City, 1929. 48 pages, 142 tables and illustrations. Paper, 6 x 9 in. Price 50 cents.*

BECAUSE of its fundamental and comprehensive nature, this bulletin, which has been under preparation by the American Welding Society for the past three years, represents one of the most valuable undertakings of that body to date. The text covers nomenclature, definitions, abbreviations and symbols in a field where there has been much confusion in these respects.

The committee preparing this booklet was made up of authorities on the various welding processes and a representative from the United States Bureau of Standards, as follows:

James W. Owens, Newport News Shipbuilding & Dry Dock Co., chairman; A. M. Candy, Westinghouse Electric & Manufacturing Company; J. J. Crowe, Air Reduction Sales Company; J. H. Deppeler, Metal and Thermit Corporation; W. B. Miller, Union Carbide & Carbon Research Laboratories; H. H. Moss, Linde Air Products Company; W. L. Warner, General Electric Company; H. L. Whittemore, Bureau of Standards; H. A. Woofter, Swift Electric Welder Company.

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Heat Exchange

EVAPORATING, CONDENSING AND COOLING APPARATUS. *By E. Housbrand; fourth English edition revised by Basil Heastie. Published by D. Van Nostrand Company, Inc., 250 Fourth Ave., New York City. 468 pages; 6 x 9 in.; cloth; price, $8.*

DEALING with the thermal calculations necessary in the design of heat exchange equipment, this book gives formulas and tables of useful data for that purpose. Particular attention is given to evaporators, heating liquids with steam-heated coils, condensers of all types and cooling of liquids.

The chapters on flow of liquids, vapors and gases through pipes has been completely rewritten to include the work of Dr. Stanton, and viscosity data for steam and other fluids are given for use in the curves of flow determined by Reynolds, Stanton and Lander. It should be noted, particularly by American readers, that the metric system of units is used throughout the book.

BOOKSHELF

The Iron Age

SEVEN IRON MEN. *By Paul DeKruif. Published by Harcourt, Brace & Company, 383 Madison Ave., New York City, 1929. Cloth; 241 pages, illustrated. Price, $3.*

LIFE sometimes is more thrilling than any fiction could be, and it is much more significant. What men have done, and why, is basic to the understanding of what they will do. When, in addition, their achievements have been responsible for a vast extension of the supply of that material without which an engineer is helpless—iron—then he in particular will give heed.

"Seven Iron Men" is such an account of life. Starting with the immigration of Lewis Merritt and his family of strong sons to the head of the lakes, Mr. DeKruif in clear and gripping fashion tells the story of three generations' fight with a wilderness. From this fight came the discovery of the great Missabe Range.

Beset not only with the difficulties of forest, mountain, march and storm, but with the, to them, uncharted terrors of the seas of finance, these sturdy Merritt pioneers carried through their quest to success. Yes, success, even though others reap to-day the reward for which they strove. For the iron was what they sought through all those bitter years, even though their talk was all of wealth.

No one can read this book without gaining a fuller sense of the strength that lies in simple American men, and a better appreciation of this stuff, iron, on which our life is based. Better yet, no one can read it without enjoyment.

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The St. Lawrence Again

THE ST. LAWRENCE WATERWAY PROJECT. *By George Washington Stephens. Published by Louis Carrier & Company, 33 East 10th St., New York City. Price $6.*

TO GIVE the complete background of the development of the St. Lawrence River, the author goes way back in history to the Treaty of Utrecht in 1713. From there he traces the political vicissitudes of the great waterway down to the Niagara Falls Treaty of 1929. At the same time we are treated to an interesting picture of the remarkable growth of transportation in North America, to which is added an absorbing chapter on the international aspects of arterial waterways that takes us back to the waterways of ancient times. With this full and erudite historical portrait we are ready for a consideration of the modern aspects of the St. Lawrence projects. Here the author presents detailed chapters on the canals of Canada and the United States, the Chicago sanitary and ship canal, alternative water routes to Europe and power developments. A particularly well-rounded presentation of the Chicago diversion case is given with all its many ramifications. Likewise, power projects—past, present and future—come in for full and fair treatment. Finally, in the last chapter, entitled "Reflections," Mr. Stephens draws from the storehouse of his wide experience many conclusions that are well worth the consideration of all those interested in the possibilities of the great river.

To add to its value as a reference work, the book contains many maps and illustrations, five appendices and a complete bibliography.

Fundamentals

STEAM AND GAS ENGINEERING. *By Thomas E. Butterfield. Published by D. Van Nostrand Company, 250 Fourth Ave., New York, 1929. 481 pages; cloth. Price, $4.50.*

WRITTEN as a textbook for engineering students, this work covers power-generating apparatus utilizing energy released by the combustion of fuels, with the inclusion of sufficient thermodynamics to afford an understanding of the functioning of such apparatus in the power plant. Among the subjects covered are: combustion, grates and stokers, pulverized coal, heat and work, boilers, auxiliaries, steam turbines, steam engines, internal-combustion engines, gas producers and steam cycles.

Inasmuch as mathematics have been subordinated to explanatory notes, the book should prove a useful reference to engineers engaged in power plant work, especially those preparing for engineers' license examinations. In this connection the numerous problems at the end of each chapter will be found helpful.

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Brief Reviews

MECHANICAL WORLD ELECTRICAL POCKET BOOK, 1930. Published by Emmott & Company, 65 King St., Manchester, England; 326 pages, illustrated; price 1/6 net—New features of this ever useful handbook of electrical machinery include electricity in textile mills, estimating for wiremen, electrical calculations and new tables of constants.

THE MULHEIMER WORKS OF SIEMENS-SCHUCKER COMPANY. Published by the V.D.I.-Verlag G.M.B.H., Berlin NW 7, Germany; 111 pages, illustrated; free—An interesting description written in German of the Mulheimer works of the Siemens-Schucker Company, where steam turbines and turbine foundations are manufactured.

RESEARCH. Published by the V.D.I.-Verlag G.M.B.H., Berlin NW 7, Germany; 68 pages, illustrated; free—A collection of three highly technical reports on recent experimental work on the circulation of water in boilers, the determination of stream lines in rotating pipes, and the rate of heat flow by diffusion; for those who read German.

A.S.H.V.E. GUIDE, 1930 EDITION. Published by the American Society of Heating & Ventilating Engineers, 29 West 39th St., New York City; 532 pages of text, illustrated; price $5—The new edition of this extremely valuable reference book contains several new chapters on coal, electrical heating, physical units and specifications.

THERMAL PROPERTIES OF PETROLEUM PRODUCTS. Miscellaneous publication No. 97 of the Bureau of Standards, 1929; 48 pages; for sale by the Superintendent of Documents, Washington, D. C.; price, 15 cents. Tables of the various thermal properties of petroleum products, compiled from critical studies of the Bureau of Standards.

WATER RESOURCES PAPER No. 58. Published by the Dominion Water Power and Reclamation Service, Ottawa, Canada, 1929; 390 pages; free. The first combined report on stream-measurement results for the St. Lawrence and Hudson Bay drainage in the provinces of Ontario and Quebec. Printed both in English and French.

INDEX TO A.S.T.M. STANDARDS AND TENTATIVE STANDARDS. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., 1929; second edition; 107 pages; free. Complete list with references of the standards and tentative standards of the A.S.T.M.

FLOW OF WATER IN DRAINAGE CHANNELS. Technical Bulletin No. 129 of the Department of Agriculture, 1929; 101 pages, illustrated; for sale by the Superintendent of Documents, Washington, D. C.; price, 40 cents. A report on the results of experiments to determine the roughness coefficient n in Kutter's formula for computing the flow of water in open channels.

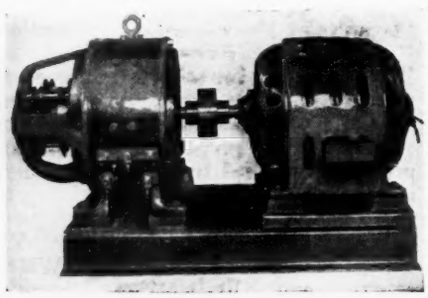
WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Motor-Generator Bases of Welded Steel Plate

ADOPTION of bases constructed from heavy steel plate electrically welded for motor-generator sets in sizes up to 250 kw. is announced by the Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, Ohio.

Tops and ends of the welded base are completely closed to prevent dirt collecting beneath the base. Pads upon which the motor and the generator rest are lined up horizontally and vertically by using the machines themselves as patterns for doing the aligning. Such shims as are needed are placed between the pads and the base. Pads with shims beneath are welded to the base. Horizontal alignment is maintained by dowels.



Unit with welded base

Automatic Bypass-Pressure Oil Filter

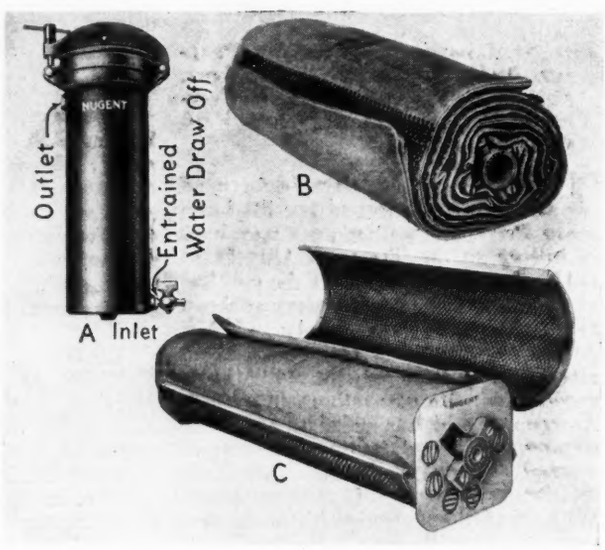
A SMALL compact pressure filter, with large capacity for the space occupied, has been designed for purifying fuel and lubricating oils by William W. Nugent & Company, 410 North Hermitage Ave., Chicago. The new product has been developed for use with Diesel engines, hoists, gear drives, large bearings, hydraulic turbines, ammonia and air compressors, pumps and other machinery of a similar character. The filter will withstand a working pressure of 100 lb., is not affected by vibration, and may be set horizontally, vertically, or at an angle, anywhere in the discharge line between the pump and the bearings to be lubricated. Clamps are available to mount the filter on engine frame, wall or bracket, or it may be immersed in a special oil tank.

An important feature of its operation is automatic bypassing of the full supply of oil to the engine or machine when the pressure drop through the filter rises to a predetermined point, as for example, when cleaning has been neglected. For a continuous supply of pure oil, duplicate units are recommended.

The view at *A* shows a typical exterior of the filter, with the inlet at the bottom and the hinged cover at the top, which may be opened readily to remove the filtering elements for cleaning. For fuel oil or lubricating oil containing water, the outlet is near the top, and a pet-cock is placed near the bottom of the case, through which entrained water is blown off.

Views *B* and *C* show the filtering equipment, consisting of four filtering elements (bags of different grades and density of fabric to suit the viscosity of the oil), which are fastened to four projecting oil nozzles on a central distributing spool through which the oil is forced into the bags. In order that the oil may reach all available filtering surface, wire-spacing mats are placed between adjacent bags, and the filtering elements and mats are rolled around the distributing spool. A hinged wire cage container keeps the bags in place, facilitates their handling and provides a space between the filtering cartridge and the wall of the casing through which the purified oil may flow to the outlet. View *C* shows this cage.

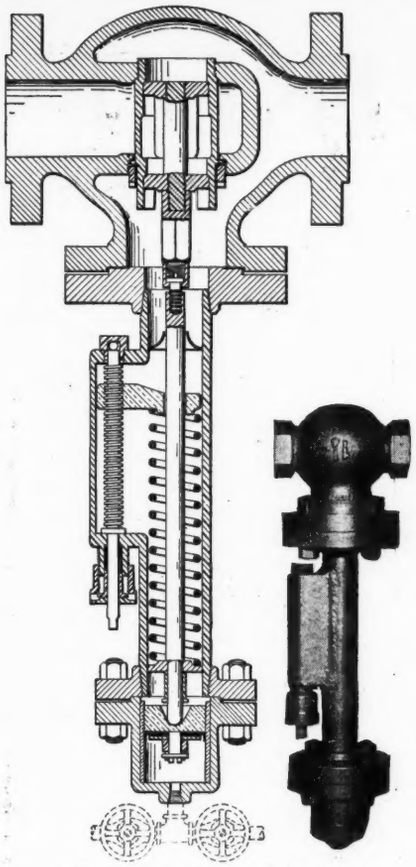
The filters are made in three different sizes, for pressure drops of 3, 10 and 15 lb., and capacities ranging from 87 to 4,637 gal. per hour, dependent upon the pressure drop and the viscosity of the oil.



Exterior view of filter, also detail of filtering bags wound around spool with wire-spacing mats, and wire cage used to hold filtering elements in place

Feed Water Excess-Pressure Regulator

FOR CONTROLLING the speed of steam-driven boiler-feed pumps so as to maintain a constant excess boiler feed-water pressure, the pump governor illustrated has been brought out by the Bailey Meter Company, Cleveland, Ohio. Internal construc-



Cross-section of regulator, and exterior view

tion of the governor is shown in the sectional view. Construction of the valve, which is fully balanced, tight-seating and readily removable, is similar to that furnished with the Bailey thermo-hydraulic feed-water regulator illustrated and described in the July 30, 1929, number of *Power*. In this valve the cage is made tight in the body by a sealing flange and a clamping nut. This provides flexibility in the cage for differences in expansion or contraction, and precludes the possibility of distortion of the valve seats.

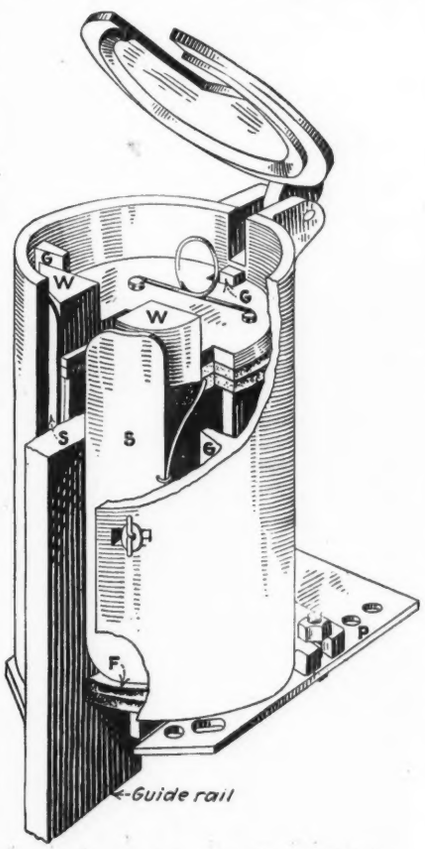
The governor is installed in the steam line to the turbine or reciprocating engine which drives the feed water pump, with the spring and piston end of the governor placed vertically downward from the steam line. This insures the bonnet being kept full of condensation, which protects the spring and piston against damage from exposure to high steam temperatures. Feed-water pressure is applied to the under side of the piston and this balances the steam pressure transmitted through the water seal surrounding the spring, plus the pressure exerted by the spring itself. The amount of excess pressure in the feed water line is regulated by adjusting the tension of the spring mounted on the side of the bonnet.

Improved Grease-Type Elevator Guide-Rail Lubricator

AUTOMATIC LUBRICATION has become a part of this machine age. The mechanic with an oil can in his hand chasing hot bearings no longer has a place in modern machinery operation. There were too many uncertainties in the old way—and the biggest one was the human element. Modern methods tend toward providing lubricant in quantities near the bearings with automatic means to supply them in accordance with their requirements.

A new type of guide-rail lubricator designed to operate on high-speed elevators has recently been placed on the market by Yvan Zenon, 244-22 136th Ave., Rosedale, N. Y. It is an improved design of one that has been in operation for several years. The new lubricator is provided with an adjustable mounting to allow easy attachment to any guide shoe. It is made to meet the requirements of high-speed as well as slow-speed elevators.

The bottom of the grease reservoir is sealed to the guide rail by a felt pad *F*. On top of the grease is a weighted pad that moves on three guides *G*. This pad is counterweighted at the guide rail by the weights *W*. Placing extra weight on the pad at the guide rail and by guiding it in the reservoir prevents the pad from binding on the elevator guide rail even at high speeds. The front of the reservoir is sealed to the guide rail by two spring-actuated fiber shutters *S*. The lubricator is supported on a plate *P* that has holes so located as to allow mounting on any type of car or counterweight guide shoe.



Sectional view through lubricator

A light grease and graphite compound is recommended for the rails by the manufacturer of the lubricator. Grease is packed in the reservoir around the guide rails and is applied to them by the movement of the car and counterweight. Lubricant is supplied only when the car is in motion, the action being much the same as if the grease were applied by a soft brush rubbing on the surface of the guide rails. Each lubricator holds about 2 lb. of grease, which is sufficient for one year on an elevator as operated in the average office building.

New Water-Softening Zeolite

A NEW water-softening zeolite known as "Basex," for replacement in all makes of zeolite water softeners operating on either the up-flow or down-flow principle, has recently been introduced by the Inversand Company of Hungerford & Terry, Inc., Clayton, N. J. This zeolite is an olive-black sand which has been screened to filter specifications. It is manufactured from green sand, otherwise known as glauconite.

Among the claims made for this new zeolite by the manufacturer are: It requires only ten minutes' time for complete regeneration, possesses an extremely high base exchange value and consumes a low quantity of salt for its regeneration. With an effective size of 0.36 millimeters and a uniformity coefficient of 1.40, it permits high rates of flow and minimum pressure losses, and the hardness and durability results in a minimum deterioration. It is furnished in 150-lb. bags.

CORRECTION—In the description of the new heat exchanger with closely spaced swaged tubes manufactured by the Griscom-Russell Company, 285 Madison Ave., New York, which appeared in the Feb. 18 number, the trade name was incorrectly spelled. It is "Equaflo," not Equaflow as it appeared.

NEWS of the FIELD

Spot News

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BOTH REPORTS *submitted last week to the committee investigating revision of the New York State Public Service Commission Law agreed that the commission should be a quasi-judicial body. One, however, urged the appointment of a people's counsel and the full control of all holding, engineering and other companies affiliated with the utilities. They also differed over valuation methods, one holding to the "prudent investment" principle and the other to "initial cost."*

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AIRPLANES *will transport the equipment of a 1,200-kw. power plant into the heart of the New Guinea jungle for the development of gold-dredging operations, according to present plans of Placer Development, Ltd., of Vancouver, B. C., which holds rights to the dredging property.*

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PURCHASE *of a controlling interest in the Seattle Lighting Company by the Portland Electric Power Company was announced last week. Simultaneously it was reported the holdings of the Portland company had been transferred to the Central Public Service Company of Chicago, and it is proposed to change the name of Portland Electric to Pacific Northwest Public Service Company.*

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NEW UNIT NO. 11 *of the Southern California Edison Company's Long Beach steam station was placed in service last week, increasing the capacity of the station to 415,000 kw. With the exception that single-pass superheaters instead of three-pass are used, the new unit is identical with unit No. 10, installed in 1928.*

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CONTRACT *for the supply of three 35,000-hp. vertical-shaft turbines of the Kaplan type for the new Russian hydro-electric plant on the Swir River has just been awarded by the Soviet government to Karlstads Mekaniska Verkstads Aktiebolag of Verkstaden, Sweden.*

A.S.M.E. Anniversary Celebration to Re[illegible] Engineering Progress of 50 Years

Program includes re-enactment of first meeting, historical pageant and papers from all parts of the world

FIFTY years of engineering progress will be reviewed by pageant and monograph at the 50th anniversary celebration of the American Society of Mechanical Engineers, according to the program recently announced by the society. The celebration will take place on April 5 to 9 at society headquarters and the offices of the *American Machinist* in New York City, at Stevens Institute of Technology in Hoboken, N. J., and at Washington, D. C.

Perhaps the most significant feature of the whole celebration will be the presentation of a series of sixteen papers, each to summarize and evaluate the influence of engineering upon cultural, social, economic, and political life. Each will also visualize the future of the engineer's place in the promotion of the common welfare in one of the sixteen selected geographical divisions of the world. The authors of these sixteen monographs, distinguished engineers in the section of the world of which they write, will be awarded a Fiftieth Anniversary Medal, which has been specially designed to commemorate the occasion. A partial list of the foreign representatives is as follows:

Austria, Hofrat Ing. L. Erhard; Belgium, Staff of six eminent engineers, represented by Baron Gaston deBethune; Canada, Brig.-Gen. C. H. Mitchell; Czechoslovakia, Dr. Stan. Spacek; France, Georges Claude; Germany, Prof. Dr. Ing. Conrad Matschoss; Great Britain, Loughnan St. L. Pendred; Italy, Senator Luigi Luiggi; Japan, Dr. Masarvo Kamo; Netherlands, Prof. Ir. D. Dresden; Scandinavia, Vilhelm Nordstrom; South America, Prof. Gaminara of Uruguay and Prof. Julio Garzon Nieto of Colombia; Switzerland, Prof. A. Stodola.

In New York, the delegates, members, and guests will register at the United Engineering Societies Building, on Saturday, April 5, when credentials will be presented. This will be followed by an unveiling of the memorial tablet commemorating the Fiftieth Anniversary of the society, and then the group will be taken to the offices of *The American Machinist* where a program will depict the preliminary meeting of organizers held in that publication's office on February 16, 1880.

In the afternoon the program will be

Medal commemorating 50th anniversary of A.S.M.E.

continued at Stevens Institute of Technology with an anniversary pageant commemorating the organization meeting of the society. It was in the auditorium at Stevens that the organization meeting of the A.S.M.E. was held on April 7, 1880, and here will be depicted a pagean of engineering progress, written by D. George Pierce Baker of the Dep[illegible] of Drama of Yale University. [illegible] be divided into three parts, entitled "The Beginnings," the "Age [illegible] Steam," and the "Age of Electric[illegible] Appropriate music will accom[illegible] the presentation throughout.

At 7:30 p.m. on Saturday a dinner of welcome will be given at the Hotel Roosevelt in New York City, under the auspices of the Metropolitan Section. Charles M. Schwab will act as toastmaster at this dinner, and the speakers will be Charles Piez, James H. McGraw and Robert I. Rees.

AFTER SPECIAL commemorative services at the Cathedral of St. John the Divine in New York City on Sunday, the party will leave for Washington. There on Monday morning at 11 o'clock in United States Chamber of Commerce Building will be held the welcoming assembly.

In the afternoon there will be a session on the "Influence of Engineering upon Civilization," when seven of the sixteen national papers covering the humanistic aspects of engineering will be summarized by their distinguished authors in short addresses. This will be followed by a reception at the White House, while in the evening a reception will be given by the officers.

On Tuesday the second part of the session on the "Influence of Engineering upon Civilization" will be held when the remaining nine national monographs will be presented and an address summarizing "Fifty Years of Mechanical Engineering in the United States."

At noon on Tuesday will be held a luncheon in honor of the founders of the society and this will be followed by the ceremonies attendant upon the presentation of medals of distinction.

Fiftieth Anniversary Medals will be conferred upon the sixteen men who will present the monographs. This occasion has been deemed unusually appropriate for the presentation of four other medals—the A.S.M.E., the Gantt, the Melville, and the Guggenheim, to William Leroy Emmet, Fred J. Miller, Joseph Wickersham Roe, and Orville Wright, respectively. This particular part of the exercises will be in charge of Dr. Arthur M. Greene, Jr., dean of engineering at Princeton University.

At a formal dinner on Tuesday evening at which Dr. W. F. Durand, past-president of the society will preside as toastmaster, there will be addresses by Charles Piez and by Dr. Robert A. Millikan. The announcement and first presentation will be made of the Herbert Hoover Medal at this time.

Excursions to points of interest in and around Washington will be made on Wednesday, when the celebration will come to an end.

Drastic Supervision of Steam Plants Advocated by New York Bill

Provides rigid code for all power and heating installations and registration of master steam fitters

A BILL to amend the labor law in relation to the installation and inspection of steam power and heating plants has just been introduced in the New York State Legislature by Assemblyman William F. Condon, Republican of Yonkers. Sponsored by labor interests, the measure aims at drastic supervision by the Department of Labor of all existing and future plants, whether in public or private buildings, and provides for the registration of all master steam fitters.

Under the terms of the act, a division of steam power and heating plants would be created in the Department of Labor, to be headed by a practical man of not less than ten years' experience in steam plant work. His duties and pay are to be determined by the industrial commissioner, who will appoint other employees needed for carrying out the provisions of the measure. The industrial board of the department shall prescribe a code for the installation, alteration and equipment of steam power and heating plants; applicable to plants now installed, to be installed, and the alterations to existing and future plants. It shall include specifications covering materials, workmanship and manner of executing such work.

Before any construction or alteration of existing buildings may be authorized by any local authority, the plans for the installation and alteration of the steam power or heating plants shall be submitted to the industrial commissioner for approval. A ten dollar fee must accompany all such plans. Furthermore, according to the act, no steam plant hereafter installed shall be operated until approved by the industrial commissioner. The commissioner also has the authority to order any existing plant not constructed in accordance with the code to be so altered as to conform thereto, but the owner of the property has the right of review of such order by the board. Rigid inspection of all plants is prescribed for carrying out the provisions of the measure, and any person violating it shall be guilty of a misdemeanor.

The bill further provides for the registration of all master steam fitters with the industrial board at a fee of five dollars. Registration must be renewed the first of every year without payment of further fee. Each registrant will receive a card, which must be kept and exhibited whenever asked for. Failure to have a certificate of registration while on the job makes the master steam fitter guilty of a misdemeanor and liable to a fine of $100. A public record of registration will be kept, and certificates may be revoked for cause after a proper hearing. A revoked certificate will not be renewed within the period of a year.

If passed, the act would go into effect July 1, 1930. It is similar in every detail to a bill introduced last year by Assemblyman Mark C. Kelly, Democrat of Utica, and killed by the legislature.

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India Constructing Large Water Power Project

A hydro-electric power project of great economic importance and of considerable engineering interest is now being constructed in connection with the Upper Ganges Canal by the Indian United Provinces Government. This major canal which commands some 4,609,000 acres of highly fertile land in the northwest of the provinces, and produces a big annual revenue in irrigation dues, has hitherto been maintained for irrigation purposes only.

Some years ago the local government decided to use certain of these falls for the generation of hydro-electric power, and in 1927-28 sanctioned two local schemes, at Rhola and Palra, to generate power for use in the adjacent towns of Meerut and Khurja, and also to pump 100 sec-ft. from a local river to supplement the canal supply. In 1928 a more ambitious project was prepared for generating 2,400 kw. at Bahadurabad and utilizing it by means of 200 miles of transmission lines for supplying the two agricultural districts of Bijnor and Moradabad with cheap power.

These three local schemes have now been joined into one general system, or grid, which is being constructed over the seven western districts of the provinces. The lines are being developed in such a way that by duplication of circuits the whole of the power which can be developed on the 13 canal falls, namely 27,000 kw., can be utilized.

An important economic feature of the plan is that no more capital is being laid out at any period than is necessary for the installation of the plant justified by the loads which can be guaranteed at that time. As and when additional loads develop, more falls will be linked into the system, thus insuring that at no time will the project be overcapitalized. The new power stations are being constructed over the existing falls instead of on separate foundations in a bypass channel. Thus economy in outlay is effected, the stations themselves costing less than one-half the cost of separate buildings.

Lively Power Utility Hearings Mark Week in Washington

HAPPENINGS in the power and public utility field were front-page news last week as four major hearings got under way at Washington. On Feb. 24, the Federal Trade Commission began its inquiry into the financial phase of the public utilities investigation, which, for the past two years has delved into propaganda activities. Officers of the American Gas & Electric Company were up for questioning as to the managing methods and general financial set-up of this large group. During the course of the hearings six major points bearing on the status of the company were brought out by Frank Buckingham, of the economic division of the commission. They are: First, participation of the Electric Bond & Share Company in the organization of the American Gas & Electric Company; second, the rapid growth of the American Gas & Electric Company; third, purchase and sale of the American Electric Power Company by the American Gas & Electric Company; fourth, the merger to form the Appalachian Electric Power Company; fifth, the fact that, of the total of 1,905,223 shares of common stock of the American Gas & Electric Company, issued up to 1927, 81 per cent were issued as stock dividends; and sixth, the fact that most of the preferred stock of the American Gas & Electric Company was issued in exchange for common stock of other companies.

Muscle Shoals

On Muscle Shoals, William B. Bell, president of the American Cyanamid Company appeared before the House Committee on Military Affairs to explain the terms of the contract under which his firm hopes to operate the federal properties for the manufacture of fertilizer. He said the contract would provide for an expenditure on the part of the government of $60,000,000 for the completion of the construction on the project, and that the government would receive a return of $4,000,000 a year in interest from the Cyanamid company on the money appropriated, and that cheap fertilizer would be furnished the farmers. If the government does not make this expenditure, the company cannot furnish the cheap fertilizer because of lack of adequate power, he explained.

At the same time Muscle Shoals lobbying activities on a scale hitherto unsuspected were being revealed by the Senate Lobby Committee as Chester H. Gray, Washington representative of the American Farm Bureau, was called to the stand. Active in support of the Cyanamid offer for the Shoals properties, Mr. Gray and his Alabama representative, A. O'Neil, according to the record, have used every possible means to impress their views on the people, on Congress, and on the White House. So bewildering is the maze of evidence which has developed that it is both difficult and unfair at this time to draw conclusions as to whether these activities were all legitimate lobbying, recognized as inevitable under a democratic form of government, or whether in some instances they go farther than that.

Power Commission

Before the Senate Committee on Interstate Commerce the internal troubles of the Federal Power Commission are being brought to light. President Hoover has endorsed the bill of Senator Couzens, chairman of the committee, providing a full-time commission instead of control by three Cabinet members with other duties. M. C. Tyler, chief engineer of the commission, however, disagreed with Mr. Hoover, stating that "an independent commission would result in more delay and deadlocks than at present, and would be satisfactory to no one."

F. E. Bonner, executive secretary of the commission, continued answering charges brought against him by Charles A. Russell, solicitor of the commission, and William V. King, chief accountant. He denied he was in any way tied up with the interests of the power companies, and tried to discredit Russell's integrity by pointing out alleged descrepancies in the management of Russell's personal finances.

O. C. Merrill, former executive secretary of the commission, testified the delays in accounting work, were due wholly to the lack of adequate personnel. The 1928 report of the commission, asking for larger appropriations contained a section pertaining to the Niagara Falls valuation matter, which was cited to show the need for a larger accounting staff. It was deleted, he said, by commission instructions under power company influence.

Agreement on Boulder Dam Waters Reached

Agreement between the California factions as to the division of waters from the Boulder Canyon project has been reached after a series of meetings held last week in Los Angeles. Of the 4,400,000 acre-feet allotted to California from the Class A main stream waters, the agricultural group—that is, the Imperial Valley—is to get 3,850,000, and the metropolitan water district 550,000. From the unapportioned surplus the district will receive an additional quantity up to 550,000. Any remaining surplus available to California over this 1,100,000 acre-feet will go to the Imperial Valley. Apparently Arizona's stake in the surplus might reduce the metropolitan allotment to 1,050,000 after the ultimate developments for use have been made, but this is an eventuality of no present consequence.

This agreement seems to clear up the situation as concerns division of water. The allocation will supply drinking water to 7,200,000 people, according to estimates, and irrigation to 140,000 additional acres now semi-arid.

No further action is reported on power allocation. Legal aides of the Interior Department still are working on complexities in the contract forms which soon will be sent to parties desiring to purchase power.

Mexico Still Affected by Power Shortage

Although the new steam-power plant of the Compañia Nacional de Electricidad at Torreon, Coahuila, Mexico, has been put in operation, mining activities in Chihuahua are still hampered by lack of power, as a further cut in the supply from the Boquilla dam has become necessary. The initial unit of the Torreon plant has a capacity of 12,000 kw., and additional units will bring the capacity up to 27,000 kw. by April.

Rainfall has several times proved inadequate to tide the Boquilla plant, controlled by Electric Bond & Share, over the Mexican dry season. In the fall of 1929 a cut of 25 per cent in the company's supply of power to Chihuahua mining properties was necessary, but the amount of water back of the dam is so low that the recent additional cut was imperative.

Commonwealth Edison Breaks Records

Reports of the engineers of the Commonwealth Edison Company, just issued, show that in 1929 the company established a new high record for output of electrical energy. The total energy produced and purchased was 4,276,181,000 kw.-hr., as compared with 3,851,106,000 kw.-hr. in 1928. The increase was as great as the company's annual output twenty years ago, the engineers say.

The company's Crawford Avenue station in December broke several records, including the world record for output of a single station. With an installed capacity of 425,000 kw. and an absolute maximum of 406,300 kw., the average daily demand was 360,830 kw., and the total output for the month was 206,452,440 kw.-hr. The operating load factor for the month was 76.9 per cent, and the capacity factor 65.5 per cent. The B.t.u. per pound of coal was 10,715, and the B.t.u. for each kilowatt-hour sent out was 14,723. The amount of coal burned for each kilowatt-hour sent out was 1.37 lb. The net output of the Crawford Avenue station for the year was 2,006,768,800 kw.-hr., which was 43 per cent of the company's total output and nearly equal to the entire output of the company in 1922.

Forest Nagler to Develop Research for A. O. Smith

After 23½ years of continuous service with the Allis-Chalmers Manufacturing Company, of Milwaukee, Wis., Forrest Nagler resigned at the first of the year to take a position with the A. O. Smith Corporation of the same city. His new work will be the formation of a general engineering research organization devoted to large-scale manufacturing problems. In this work, Mr. Nagler will have a wonderful opportunity, for one of his outstanding characteristics is the ability of not only being able to produce himself, but also to bring out the best in his associates.

On June 30, 1906, soon after graduation from the University of Michigan, Mr. Nagler entered the student apprenticeship course of the Allis-Chalmers company. Upon completion of this course in 1908, he joined the hydraulic department to follow the special training obtained at the university, and in the course of years he became prominently known in the hydro-electric field. His most outstanding work with the company was the development of the high-speed propeller type runner, which now represents an appreciable amount of the hydraulic department's business. A description of this development, presented at the annual meeting of the American Society of Mechanical Engineers in December, 1919, was responsible for the award of a life membership in the society.

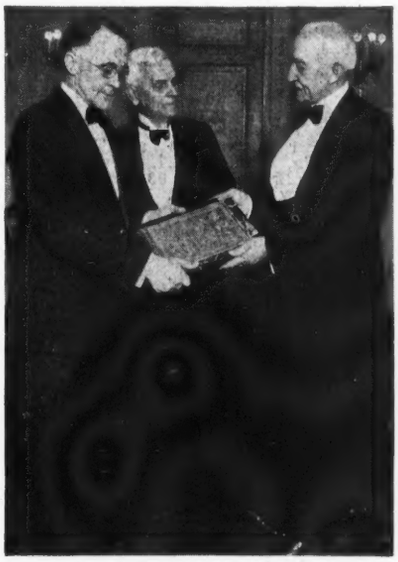
Dean Cooley Receives Washington Award

At a dinner meeting of the four founder engineering societies and the Western Society of Engineers at the Palmer House, Chicago, on the evening of Feb. 24, Dr. Mortimer E. Cooley, dean emeritus of engineering at the University of Michigan, was honored by the presentation of the Washington Award for 1930.

Since its establishment in 1916 by John W. Alvord, past president of the Western Society of Engineers, this award has been bestowed upon eight distinguished engineers, of whom Herbert Hoover was the first. It was founded to give recognition for pre-eminent services in the promotion of human welfare and for outstanding instances of public and professional devotion. The recipient of the award is selected by a commission of seventeen members, nine from the Western Society of Engineers and two from each of the founder societies.

Over 300 engineers attended the dinner. C. B. Burdick, chairman of the commission, presided. Greetings from the four founder societies were offered by Dr. A. N. Talbot for the American Society of Civil Engineers; by William Kelly for the American Institute of Mining and Metallurgical Engineers: by W. L. Abbott for the American Society of Mechanical Engineers, and by R. F. Schuchardt for the American Institute of Electrical Engineers. William S. Monroe, president of the Western Society of Engineers, presented the award.

In his response Dean Cooley said, in part, "The present is a period of achievement. The future must be a period of responsibility for that achievement. The education of engineers in colleges today is not so broad as that of early engineers. An engineering graduate today is thoroughly trained in one thing and often comparatively ignorant of other things." The speaker strongly favored a broader education for engineers necessitating curricula that would require five or six years.



Dr. M. E. Cooley receiving the Washington award tablet from W. S. Monroe and C. B. Burdick

Upon the conclusion of the program outlined, Dr. Howard McClenahan, secretary of the Franklyn Institute, Philadelphia, delivered an address on "The Engineer's Gifts to Humanity" and in behalf of the institution he represented elected Dean Cooley to honorary membership.

To Develop Klickitat River

A temporary permit allowing two years to complete investigations, studies and plans before commencing construction has been issued by Charles J. Bartholet, Washington State hydraulics supervisor, to the Yakima-Klickitat Power Company for appropriation of 350 sec-ft. of water from the Klickitat River for a proposed $1,500,000 hydro-electric power project. A diversion dam 20 ft. high and 150 ft. long would be located in Yakima County near the base of Mount Adams, and canals and flumes would carry the water about 9½ miles southeastward to the power plant, in northern Klickitat County, where a fall of 600 ft. would be utilized to develop 23,865 theoretical horsepower.

News of Canada

Equipment purchased for Beauharnois and Gatineau—B. C. to consider power regulation—West Kootenay makes progress at Granite Dam

THE Dominion Engineering Works has just closed a contract with the Beauharnois Light, Heat & Power Company for the supply of waterwheels for the big power house to be built by Beauharnois on the St. Lawrence. The contract calls for four 50,000-hp., and two 8,000-hp. waterwheels, together with the embedded parts for six more wheels. The two 8,000-hp. units will be utilized for the generator exciters and for general plant use. Together with the four 50,000-hp. units, they will go into operation by Oct. 1, 1932. Further turbines to bring the plant up to its full initial capacity of 500,000 hp. will be ordered from time to time. During the next few months the corporation will place orders with electric equipment companies for the generators.

Foster Wheeler Company, Ltd., of Toronto, Ont., has closed an important contract with the International Paper Company for a complete steam-generating plant for the company's new newsprint mill at Gatineau, Quebec. Equipment includes boilers, soot blowers, pulverized-fuel equipment, water-cooled furnaces, superheaters, air heaters, forced- and induced-draft fans.

B. C. Power Regulation

Questions filed by Opposition members of the British Columbia Provincial Legislature indicate that the control of water powers will be made a leading issue in the present parliamentary session. A proposal, advanced at the last session, that no water power over 40,000 hp. should be given to any company without the consent of the House, is likely to be revived. Since that session Hon. F. P. Burden, Minister of Lands, has informed the House that rights have been granted to the British Columbia Electric Railway Company to develop Campbell River, Vancouver Island, and to the Western Power Company of Canada, subsidiary of the former, to develop the Stave River at Ruskin. Both developments involve well over 40,000 horsepower.

Granite Dam Progress

Excellent progress is being made by the West Kootenay Power & Light Company on preliminary construction work on the Granite Dam, near Nelson, B. C. This dam is being erected to impound the waters of Kootenay Lake to give better control over the flow of the Kootenay River, on which are situated the three hydro units of the power company. Fifty men are employed at present preparing the construction camp and on other preliminary work. About 200 men will be employed when construction is started.

Open High-Pressure Pipe Plant in South

On March 1 a representative group of engineers inspected the new pipe-fabricating plant at Atlanta, Ga., of the General Fire Extinguisher Company, which sells its products exclusively through the Grinnell Company. The opening of this new plant is significant of the growth and development of super power in the Southern States, as it is the only plant in the South where pipe fabrication for steam pressures up to 1,350 lb. can be made.

The plant is located on the Southern Railway at Highland Ave., adjoining the storehouse, foundry and machine shop of the company. The main pipe fabricating plant is of heavy steel and concrete construction with steel sash side walls. Cranes serve the plant throughout. The area of this new building is approximately 16,500 sq.ft. The testing floor is of ramp type construction, served with a low-pressure pump for quick filling and a large power test pump of 5,000 lb. capacity.

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Obituary

JOSEPH H. BRAGDON, publishing director of *Textile World* and vice-president and general manager of the Bragdon, Lord & Nagle Company, division of the McGraw-Hill Publishing Company, publishers of that paper, died suddenly of pneumonia Feb. 19, at his home in New Rochelle, N. Y. Mr. Bragdon was born in Melrose, Mass., June 9, 1887. His father, Joseph H. Bragdon, founded *Textile Manufacturers Journal* in 1894. When the son graduated from Yale in 1911, he joined the staff of that publication. In 1915 he was active in a merger which joined *Textile Manufacturers Journal* and *Textile World Record* into one publication, *Textile World*. Mr. Bragdon was a member of the executive committee and of the board of directors of the McGraw-Hill Publishing Company. He was past president of the New York Business Publishers Association and the Associated Business Papers.

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CHARLES E. EATON, an engineer with offices in Watertown, N. Y., for 25 years, died at his home in Clayton, N. Y., on Feb. 4. His work included the design of power plants in northern New York, including the Wilder development at South Edwards, the Chasm Falls development at Malone and plants at Higley Falls and Fulton. Mr. Eaton, who was 71 years old, retired from active practice two years ago.

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THOR WOLLEBAK, southwestern representative of the Delta-Star Electric Company, Chicago, Ill., died Jan. 30 at Dallas, Tex. He had been with the company for many years.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers, District meeting at Springfield, Mass., May 7-10. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting at society headquarters in New York City, April 22-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

Engineering Institute of Canada. Annual meeting at the Chateau Laurier, Ottawa, Ont., Feb. 12-14, 1930. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

National Power Show. Held in connection with the International Textile Exposition at Mechanics Building, Boston, Mass., April 28 to May 3. For information, write to the New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

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Personals

V. E. MCCOY, formerly employed by the Milwaukee Railroad as combustion engineer, has now become connected with The Bird-Archer Company, Chicago, Ill., as assistant to the president.

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LOUIS J. SCHRENK, power plant superintendent for the department of public lighting, Detroit, Mich., was promoted recently to the position of general superintendent of the public lighting system.

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JOHN HICKEY, inventor of the direct-contact open feed-water heater, has again joined the engineering staff of the National Pipe Bending Company of New Haven, Conn. He will have direct charge of engineering in connection with research and new-product development.

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H. HOBART PORTER was elected chairman of the Research Board of the Engineering Foundation at the annual meeting of the board on Feb. 20. OTIS E. HOVEY and G. H. CLEVENGER were elected vice-chairmen, and GANO DUNN and GEORGE L. KNIGHT, members of the executive committee. ALFRED D. FLINN was named director and secretary.

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PERRY M. TEEPLE, formerly associate professor at the University of South Carolina, has recently joined Feedwaters, Inc., as its South Carolina representative.

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SAMUEL INSULL, who has been president of the Commonwealth Edison Company and the People's Gas Light & Coke Company for a number of years, will become chairman of the board of both these organizations, and SAMUEL INSULL, JR., will become vice-chairman, according to recent reports. EDWARD J. DOYLE will become president of the Commonwealth Edison Company and J. H. GULICK will become chairman of the finance committee. Both Mr. Doyle and Mr. Gulick have been vice-presidents.

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DR. ROBERT H. FERNALD, Whitney professor of dynamical engineering and director of the mechanical engineering department at the University of Pennsylvania, has been appointed dean of the Towne Scientific School of the university. Dr. Fernald is prominent in many fields of mechanical engineering endeavor, at one time serving as a member of the giant power survey board in Pennsylvania.

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ELI WATKINS, chief engineer at Sterling, and C. BYRON HALL, district manager at Estes Park, for the Public Service Company of Colorado, will be awarded Insull medals for saving the lives of Hans P. Greve, Jr., and F. M. Cropper by means of the Schaefer prone-pressure method of resuscitation.

Business Notes

ROLLER-SMITH COMPANY, New York City, announces the following changes in its sales organization: M. W. Seymour is now associated with the New York office as a sales engineer; H. D. Stier, 101 Marietta St., Atlanta, Ga., is representing the company in Alabama, Florida, Georgia, North and South Carolina; and the H. N. Muller Company, First National Bank Building, Pittsburgh, Pa., now represents Roller-Smith in western Pennsylvania, West Virginia and the Youngstown district of Ohio. Associated with Mr. Muller are H. E. Ransford and F. E. Harper.

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GRISCOM-RUSSELL COMPANY, New York City, announces that after March 1 its Chicago office will be located at Room 1442, 20 North Wacker Drive, Chicago, Ill.

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LINK-BELT LIMITED recently opened a branch office in the Standard Bank Building, 510 West Hastings St., Vancouver, to serve more intimately its growing list of customers in British Columbia, Canada. Frank B. Whetherill, is in charge of the new branch.

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THE CONNERSVILLE BLOWER COMPANY, Connersville, Ind., announces that John T. Wilkin, president and chief engineer, was also chosen general manager at a recent meeting of the board of directors. At the same time Bernard C. O'Brien, formerly in charge of sales at Pittsburgh, was elected secretary; W. E. Newkirk, purchasing agent, became treasurer; and E. C. Hassler, assistant superintendent, was appointed acting superintendent. The last three selections were to fill vacancies due to the deaths of J. E. Huston, secretary-treasurer, and R. T. Huston, vice-president and superintendent.

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MOELLER INSTRUMENT COMPANY, Brooklyn, N. Y., is successor to the A. E. Moeller Company. Active ownership and management remain the same as they have been for many years past.

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CONSOLIDATED PRODUCTS COMPANY, New York City, announces the addition of George W. Maisak, of Brooklyn, to the sales staff of its crushing, pulverizing and drying machinery department.

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BETSON PLASTIC FIRE BRICK COMPANY is the new corporate name of Betson-Jewell, Inc., Buffalo, N. Y. The same products will be produced and sold under the direction of J. H. Vought, president, and J. F. Beckert, vice-president of the company, with general offices at 822 East Delavan Ave., Buffalo.

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With the SOCIETY SECTIONS

Cleveland Engineering Society. Fiftieth anniversary celebration meeting at the Hotel Hollenden, Cleveland, Ohio, on March 14-15.

Midwest Bituminous Coal Conference. Held under the direction of the Engineering Schools of Purdue University, Coal Trade Association of Indiana and Illinois Coal Bureau, at Lafayette, Ind., April 9-11. Chairman, W. A. Knapp, Purdue University, Lafayette, Ind.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

Northwest Electric Light & Power Association. Engineering section; seventh annual meeting at the Hotel Morck, Aberdeen, Wash., March 26-28. Secretary, B. H. Snow, 1206 Spalding Bldg., Portland, Ore.

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Trade Catalogs

PUMPS—A recent folder of Layne & Bowler, Inc., Memphis, Tenn., describes and illustrates the construction and operation of deep-well pumps.

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OIL FILTERS—A high-pressure automatic by-pass oil filter for fuel and lubricating oils is described in an illustrated circular just issued by William Nugent & Company, 410-12 North Hermitage Ave., Chicago, Ill.

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REFRACTORIES—"Modern Refractory Practice" is the title on an unusually well-compiled treatise on refractories published by the Harbison-Walker Refractories Company, Pittsburgh, Pa. Contained in its 178 attractively illustrated pages is a large amount of general information that should be of great practical value to users of refractories.

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STOKERS—An attractive catalog, the first on industrial equipment to be printed by the Intaglio method of rotogravure, has just been published by the Westinghouse Electric & Manufacturing Company, Lester Branch P. O., Philadelphia, Pa., which describes and illustrates the construction and operation of the link-grate stoker.

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METERS—The Roller-Smith Company, 233 Broadway, New York City, has recently issued two new bulletins; No. 300 covering various types of instruments for resistance measurements, and No. 210 covering portable direct-current ammeters, voltmeters, galvanometers, circuit testers, shunts and multipliers.

PUMPS—Bulletin No. 214 of the Pennsylvania Pump & Compressor Company, Easton, Pa., illustrates and describes the constructional details of the company's double-suction, single-stage centrifugal pumps.

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VALVES—"The Direct Control System of Automatic Temperature Regulation" is the title of an attractively illustrated 40-page booklet just issued by the Direct Control Valve Company, Chicago, Ill. Full details of the system with operating data and layouts are presented in this bulletin. A picture section of some of the most important buildings using the system is also included.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.30 @ $2.50
Kanawha	Columbus	1.40 @ 1.60
Smokeless	Cincinnati	2.00 @ 2.25
Smokeless	Chicago	2.00 @ 2.25
S. E. Kentucky	Chicago	1.40 @ 1.60
Steam	Pittsburgh	1.40 @ 1.65
Gas Slack	Pittsburgh	.90 @ 1.00
Big Seam	Birmingham	1.35 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.70@$3.00
Barley	New York	1.40@ 1.50

FUEL OIL

New York—Feb. 27, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Feb. 26, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.645 per bbl., or 42 gal.; 26@28 deg., $1.695 per bbl.; 28@30 deg., $1.745 per bbl.; 30@32 deg., $1.795 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh—Feb. 18, f.o.b. local refinery, 30@34 deg., fuel oil, 4.5@4.75c. per gal.; 36@40 deg., 4.62½@4.75c.

Philadelphia—Feb. 18, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Feb. 25, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Feb. 18, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.05@$1.10 per bbl.; 30@32 deg., $1.30@$1.35 per bbl.

Boston—Feb. 24, tank-car lots, f.o.b., 12@14 deg., Baumé, 3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Feb. 22, f.o.b. local refinery 26@30 deg., $1.35 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Wynne — Sewer Improvement Dist. 1, G. G. Dorris, Chn., will soon award contract for the construction of a sanitary sewage system including pumping plant, etc.

Calif., Los Angeles—Pacific Railway Co., 610 South Main St., is receiving bids for the construction of a 45 x 70 ft. sub-station. Estimated cost $20,000.

Conn., Meriden—International Silver Co., J. A. Hutchinson, 48 State St., awarded contract for the construction of a boiler house to Bartlett Brainerd Co., 252 Asylum St., Hartford. Estimated cost $50,000.

La., Shreveport—City will receive bids until Mar. 27 for the construction of a new pumping station on shore of Cross Lake in connection with waterworks system. Estimated cost $500,000.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., will receive bids until Mar. 10 for the construction of a steam heating plant at Kneeland and Utica Sts. Bigelow, Wadsworth, Hubbard & Smith, 11 Beacon St., are architects. I. E. Moultrop, 30 Boylston St., is engineer.

Mass., Cambridge (Boston P. O.)—Cambridge Electric Light Co., 46 Blackstone St., awarded contract for addition and alterations to power plant at Western Ave. and Memorial Dr. to W. S. Barstow & Co., Reading. Estimated cost $40,000.

Mass., Fall River—Fall River Electric Light Co., 85 North Main St., subsidiary of New England Power Co., 35 Harvard St., Worcester, awarded contract for the construction of a substation to New England Power Construction Co., 89 Broad St., Boston. Estimated cost $40,000.

Mass., Lee—Lee Electric Co., C. Wurtzbach, Canal St., plans the construction of a power sub-station on West Center St. Estimated cost $100,000. Private plans.

Mass., Saugus—City, W. J. Lambert, Supt. Public Works, is having sketches made for the construction of a pumping station on Vine St. Estimated cost $40,000. Fay, Spofford & Thorndike, 44 School St., Boston, are consulting engineers.

Mass., Springfield—Springfield Ice Co., 91 Dwight St., plans the construction of a new ice manufacturing plant. Estimated cost $75,000. Architect and engineer not selected.

Mich., Lapeer—Michigan State Administrative Board, W. J. Kay, Supt., Lansing, will receive bids until Mar. 12 for the construction of a home and training school including power house, etc., here. Estimated cost $1,000,000. Maul & Lentz, 1259 David Whitney Bldg., Detroit, are architects.

Miss., Pascagoula—City is having plans prepared for the construction of an ice plant, 25 ton daily capacity and storage of 150,000 to 200,000 pounds of seafood. Estimated cost $40,000. E. K. Strahan, Inc., Pere Marqette Bldg., New Orleans, La., is engineer.

Mo., Kirksville—City, plans an election Apr. 8 to vote $300,000 bonds for the construction of a municipal light and power plant.

Mo., Warsaw—City will soon award contract for waterworks and distribution systems including pumping equipment, mains, tank on tower, etc. Estimated cost $50,000. Black & Veatch, 700 Mutual Bldg., Kansas City, are engineers.

N. J., Asbury Park—E. H. Schneider, Third Ave., Archt., will receive bids about May 1 for the construction of an 11 story apartment building including steam heating and refrigeration systems, boilers, elevators, etc., at Grand and 5th Aves., for People's Building & Construction Co., F. Gunna, 28 Sanford St., New Brunswick. Estimated cost $500,000.

N. J., Atlantic City—Pennhurst Hotel Corp., c/o Cook & Blount, 415 Lexington Ave., New York, N. Y., Archts., is having plans prepared for the construction of a 14 story hotel including steam heating and ventilation systems, boilers, elevators, etc., at old Penhurst Hotel site. Estimated cost $1,000,000.

N. Y., Neponset Beach (mail Far Rockaway)—Neponset Beach Hospital, plans additions and alterations to hospital and power plant. Estimated cost $180,000.

N. Y., New York—Bellevue Hospital 26th St. and East River, plans addition to power plant. Estimated cost $210,000.

N. Y., New York—Gouverneur Hospital, Gouverneur Slip, is having plans prepared for additions and alterations to power plant. Estimated cost $42,000.

N. Y., New York—Green Terminal Building Corp., 45 West 34th St., plans addition to boiler room and factory at 62 West 35th St. Estimated cost $75,000. E. Roth, 1440 Broadway, is architect.

N. Y., Suffolk County—Dept. of Mental Hygiene, Albany, received lowest bid for completion of buildings, 3, 4 and 5, power house and service tunnels at Pilgrim State Hospital here from M. Kantrowitz Contracting Corp., 20½ Market St., Albany. $2,095,000.

O., Akron—Northern Ohio Power & Light Co., 47 North Main St., plans the construction of an electric substation at Carrol and Buckeye Sts. Estimated cost $328,800.

O., Cleveland—City is having preliminary plans prepared for waterworks improvements including high service reservoir, pumping station, filtration plant, etc. Estimated cost $1,000,000. L. A. Quayle, City Hall, is engineer.

Okla., Erick—Erick Ice Co., is having plans prepared for the construction of a 10 ton raw water ice plant. Estimated cost $25,000. Private plans.

Pa., Pittsburgh—Union Storage Co., 1409 First National Bank Bldg., is having plans prepared for the construction of a 6 story, 154 x 264 ft. dry and cold storage warehouse at Smallman St., between 22nd and 23rd Sts. Estimated cost $1,000,000. R. Irvin & Co., Vandergrift Bldg., are architects.

Pa., Sharpsburg—U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C., will receive bids until Mar. 25 for the construction of a group of buildings including refrigeration and ice making plant; etc. at U. S. Veterans' Hospital, Aspinwall, here.

R. I., Woonsocket—National Service Co., 150 Congress St., Boston, Mass., awarded contract for the construction of an ice plant here to E. D. Ward Co., 82 Foster St., Worcester, Mass.

Tex., Raymondville—Central Power & Light Co., c/o National Bank of Commerce Bldg., awarded contract for the construction of a 50 ton ice plant to Velten Construction Co., Harlingen and Brownsville. Estimated cost including equipment $45,000.

Tex., Schertz—U. S. Government, War Dept., Washington, D. C., will soon receive bids for the construction of a post exchange to include cold storage plant at Randolph Field here, 14 mi. north of San Antonio. Estimated cost $75,000. Matthews & Keenan, Smith-Young Tower, San Antonio, are architects.

Vt., McIndoe (mail McIndoe Falls)—Grafton County Electric Light & Power Co., 89 Broad St., Boston, is having plans prepared for the construction of a hydro electric power plant including transmission equipment. Estimated cost $400,000. Private plans.

Equipment Wanted

Ash and Smoke Consuming Equipment—Sioux City, Ia.—Sioux City Gas & Electric Co., Commerce Bldg., plans to install ash and smoke consuming equipment in Riverside plant.

Boiler and Boiler Equipment—Marshall, Minn.—City plans to purchase boiler and boiler equipment for municipal power plant.

Engine—Falls City, Neb.—City, c/o M. Naylor, Clk., will soon receive bids for a 1,000 hp. Diesel engine unit.

Pumping Unit—Brownsville, Tex.—Cameron County Water Improvement District No. 14, L. P. Stove, Pres., will receive bids until Mar. 18 for pumping unit, etc. in connection with proposed irrigation project. Estimated cost $300,000.

Power Plant Equipment—Springfield, Ill.—City will soon receive bids for power plant equipment, including coal handling equipment, etc.

Pumping Unit—Columbus, O.,—Bd. of Purchases, H. C. Cain, Secy., will receive bids until Mar. 13 for a 500 g.p.m. electro-centrifugal pumping unit, electric coal hoist, 1 ton capacity.

Pumps—Toledo, O.—City will receive bids until Mar. 25 for one 1,000,000 g.p.d. and one 500,000 g.p.d. raw water pumps, also three 300 g.p.m. triplex plunger pumps for proposed sewage treatment work. Estimated cost $750,000.

Pumps, Etc.—Galesburg, Ill.—Bd. of Trustees, Galesburg Sanitary District, will receive bids until Mar. 25 for pumping equipment, electrically driven centrifugal pumps, 16,000,000 g.p.d. total capacity with auxiliary equipment for proposed sewage treatment plant.

Pumps, Etc.—Franklin, Neb.—City, C. J. Goetz, Clk., will receive bids until Mar. 7 for two motor driven centrifugal pumps, etc. for proposed waterworks improvements.

Switchboards, Air Compressor, Etc.—Washington, D. C.—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Mar. 18 for switchboards, portable air compressor and electric light plant.

Transformers, Oil Drying and Testing Apparatus—Wellington, N. Z.—Dept. of Public Works Supply and Tenders Committee, will receive bids until Apr. 29 for oil drying and testing apparatus, also until May 6 for 750 kva. transformers; and until May 13 for 110 kva. transformers.

Industrial Projects

Ill., Chicago—United Autographic Register Co., 2316 West 43rd St., awarded contract for masonry, carpentry, etc., for a 1 and 2 story, factory at California Ave. and 50th St., to C. Baker, 1558 West 79th St. Estimated total cost $1,000,000.

Mich., Detroit—Bohn Aluminum & Brass Corp., 2512 East Grand Blvd., is having plans prepared for the construction of a 1 and 4 story factory for the manufacture of automobile parts and aluminum products at East Grand Blvd. Estimated cost $1,000,000. C. W. Brandt, 1016-18 Francisco Palms Bldg., ir architect.

Minn., Blue Earth—Minnesota Valley Canning Co., Le Sueur, awarded contract for addition to canning plant including new power plant to J. B. Nelson Construction Co., Mankato. Estimated cost $450,000.

N. J., Harrison—J. A. Finegan, 776 Broad St., Newark, Archt., will receive bids about April 1 for a 1 and 2 story addition to factory for the manufacture of wire products on Middlesex St. here for Driver-Harris Co., Middlesex St. Estimated cost $250,000.

N. J., Newark—General Alloy Co., 188 New Jersey Railroad Ave., is having preliminary plans prepared for the construction of a 2 story factory on Maple Pl. Estimated cost $40,000. P. B. West, 24 Commerce St., is architect.

N. J., North Bergen—G. Willaredt, 411 23rd St., West New York, Archt., will receive bids about Mar. 1 for a 3 story addition to factory here, for Theurer Wagon Works, Inc., 3923 Hudson Blvd. Estimated cost $40,000.

O., Cincinnati—Aluminum Industries Inc., Beekman St., awarded contract for two 1 story factory buildings one to Fisher-DeVore Co., Dana St., and one to Truscon Steel Co., 505 Walnut St. Estimated total cost $100,000.

O., Cincinnati—Lockwood Mfg. Co., West 3rd St., manufacturers of bakery pans and equipment, received lowest bid for the construction of a 2 story, 231 x 280 ft. factory and office on Wasson Rd. from Ferro Concrete Co., 3rd and Elm Sts. Estimated cost $150,000.

O., Cleveland—The Kroehler Mfg. Co., H. E. Moyer, Works, Mgr., 3134 Prospect Ave., manufacturers of furniture, is receiving bids for a 3 story, 79 x 200 ft. addition to factory at East 116th St. and Harvard Ave. Estimated cost $200,000. J. O. Taylor, c/o owner, Fisher Bldg., Chicago, Ill., is engineer.

O., Toledo—Libby Owens Glass Co., East Toledo St., awarded contract for a 1 story factory to A. Bentley & Sons, Belmont St. Estimated cost $300,000.

O., Toledo — Toledo Scale Co., Monroe St., awarded contract for the construction of a factory to A. Bentley & Sons Co., Belmont St. Estimated cost $1,500,000.

Okla., Oklahoma City—Amerada Petroleum Co., Petroleum Bldg., Tulsa, is having preliminary plans prepared for the construction of a casinghead gasoline plant here. Estimated cost $100,000. Private plans.

Tex., Houston—Davison Chemical Co., Baltimore Trust Bldg., Baltimore, Md., is having plans prepared for the construction of a 230 x 350 ft. chemical plant here. Estimated cost $750,000. Engineering Service Corp., 923 Post Dispatch Bldg., Houston, is engineer.

Utah, Salt Lake City—Western States Plate Glass Co., c/o F. E. McCambridge, Pres. and Treas. of Middle States Bond & Invest. Co., 818 Olive St., St. Louis, Mo., is having preliminary plans prepared for the construction of a plate glass factory. Estimated cost $5,000,000. H. L. Dixon & Co., Rosslyn Rd., Pittsburgh, Pa., are architects.

Wis., Milwaukee—Pittsburgh Plate Glass Co., 205 Pittsburgh Ave., will receive bids about Apr. for the construction of a 5 story paint manufacturing plant. Estimated cost $1,000,000. Private plans.

Ont., Peterboro—D. W. Magee, Park St., Engr., will receive bids until Mar. 8 for the construction of a 1 story, 160 x 400 ft. factory for the manufacture of switchboards for Canadian General Electric Co., Park St. Estimated cost $200,000.

Finland, Karhula—Backus-Brooks Co., 1100 Builders Exchange Bldg., Minneapolis, Minn., plans the construction of first unit of plant for the manufacture of insulating material of wood pulp, to include hydro-electric development, 25,000 hp. capacity at Abborsfors Rapids. Estimated total cost $5,000,000. Plant will be operated by Ahlstrom Co., Finland.